# F Cost and Socioeconomic Impacts

## Cost and Socioeconomic Impacts of Implementing the California Coho Salmon Recovery Strategy

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Prepared by:

David Sunding and Alix Peterson Zwane

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## F.1 INTRODUCTION

This report measures the cost of implementing the Coho Salmon Recovery Strategy (Recovery Strategy) for the Central California Coast (CCC) Coho Evolutionary Significant Unit (ESU) and the California portion of the Southern Oregon-Northern California Coast (SONCC) Coho ESU. An estimate of the cost of implementing the strategy is required by California statute governing the Recovery Strategy Pilot Program (Fish and Game Code (FGC) §§ 2105-2116). To respond to this requirement, at the request of the Department of Fish and Game (Department) and in cooperation with the Statewide Coho Salmon Recovery Team (CRT) and the Shasta-Scott Recovery Team (SSRT), economists developed quantitative estimates of both the fiscal cost and the socioeconomic impacts of implementing the Recovery Strategy. Implementing the Recovery Strategy will provide benefits for multiple species, watershed health, water quality, and the environment generally. It will also result in benefits to recreational and commercial fishing and related industries.

The report begins by describing the method used to develop aggregate costs and socioeconomic impacts of recommendations at the hydrologic unit (HU) level that are common to many HUs and hydrologic subareas (HSAs). The conceptual distinction between fiscal costs and socioeconomic impacts is then discussed and this methodology is then applied. Estimates of the aggregate cost of recovery by ESU are presented. These aggregate cost estimates do not reflect the full cost of Recovery Strategy implementation, because some costs cannot be quantified at this time. Detailed cost estimates at the HU level are provided in attachments 1-5. At this time, there is limited information available about the quantity of each recovery action that will be undertaken and these cost estimates can be revised as additional information becomes available. However, these aggregate cost estimates may overestimate the cost of Recovery Strategy implementation because some of the costs may be incurred even if the Recovery Strategy were not implemented. In addition, these aggregate cost estimates include costs that may be incurred as a result of actions taken to avoid take of coho salmon or to fully mitigate impacts of authorized take of coho salmon once the species is listed.

The aggregate cost estimates presented here include not only the cost of implementing recommendations that are common to many HU/HSAs, but also the cost of specific recommendations that respond to the unique circumstances of a single HU or HSA. Cost estimates for these specific recommendations, are included in estimates of the aggregate cost of recovery. Some of these items are a significant portion of the costs estimated here. For example, restoring coarse sediment transport near Iron Gate Dam may cost as much as $500 million. Implementing the Trinity Record of Decision is estimated to cost about $12 million per year.

The aggregate cost estimates do not include specific line items for the state-wide recommendations because the majority of these recommendations cannot be assigned an estimated cost at this time. In addition, the cost of many of the state-wide recommendations is captured by estimating the cost of the HU/HSA-specific recommendations. The economists suspect that, given the magnitude of the measured recovery costs, failure to measure the costs of the state-wide recommendations explicitly does not impact qualitatively the recovery cost calculations.

The aggregate cost estimates also include the cost of implementing recommendations regarding timberland management. In accordance with a request by the Fish and Game Commission (Commission) for a range of alternatives regarding recommendations for timberland management, three alternative sets of recommendations were presented in the November 2003 Public Review Draft of the Recovery Strategy. Cost estimates were developed for these alternatives. They are presented in section F.13. When considering the cost of implementing recommendations regarding timberland management, one must consider the estimated costs presented in section F.13 in light of the recommendations that were finally approved for inclusion into the Recovery Strategy.

Some items included in the estimate of the aggregate cost of the Recovery Strategy are costs that may be incurred even if the Recovery Strategy were not implemented. For example, the cost of implementing the Trinity River Record of Decision (about $12 million per year) and the cost of the Fisheries Restoration Grant Program ($20-25 million per year) are included as costs associated with coho salmon recovery. The decision to include these costs was made in consultation with the Department. To the extent that these costs would be incurred in the absence of this plan, the cost estimates presented here overstate the cost of Recovery Strategy implementation. Costs that would be incurred as a result of the Clean Water Act or other related statutes and regulations were excluded. While TMDL regulations, for example, are quite relevant to coho salmon recovery, costs attributable to this process are not counted as a cost of coho salmon recovery as the regulations would have been enacted anyway.

Separate cost and socioeconomic impact estimates have been developed for the Shasta Valley and Scott Valley HSAs. These cost estimates are described and presented in section F.14.

Section F.16 discusses impacts that have been identified but not quantified at this time. The magnitude of these costs will likely be an important determinant of the total cost and socioeconomic impact of the Recovery Strategy.

## F.2 METHODOLOGY CONSIDERATIONS FOR DEVELOPMENT OF ECONOMIC IMPACTS OF COMMON RECOVERY RECOMMENDATIONS

This section of the report provides estimates of the unit cost of recommendations at the HU/HSA level that are common to many HU/HSAs and the aggregate cost of these recommendations. While coho salmon recovery in Central and Northern California will require many actions that are unique to particular watersheds, the recommendations in the Recovery Strategy include several actions that are common to many HSAs. This section includes discussions of (1) the fiscal or budgetary cost of implementing these common recommendations and (2) the socioeconomic impacts of implementing these recommendations. Specific recommendations cover:

1. Removing or reducing barriers to fish passage;
2. Implementing riparian revegetation and other stream bank improvements;
3. Improving instream complexity, including the placement of large woody debris (LWD);
4. Road treatment and/or decommissioning;
5. Restoring wetlands and off-channel areas;
6. Water acquisitions;
7. Undertaking biological studies to understand and monitor salmon behavior;
8. Watershed planning and other non-biological studies;
9. Education and outreach efforts (including improvements in coordination); and
10. Changes in timberland management.

The primary focus is the unit cost of these activities. In some cases the recommendations in the Recovery Strategy do not provide guidance on the scale at which recommended activities should be undertaken because this kind of detailed information is not currently available. For example, at the HU- and HSA-level the recommendations do not specify the amount of water acquisition required to meet recovery goals. This precludes the comprehensive measurement of the cost of coho salmon recovery under the strategy. Nonetheless, it is possible to provide cost estimates for many recovery actions, and to characterize unit costs in even more cases.



### F.2.1 DEVELOPMENT OF AGGREGATE COST ESTIMATES

Aggregate cost estimates were developed with a series of spreadsheet models that have been provided to the Department. These models are designed to combine unit cost estimates with information on the potential scale at which recommended activities could be undertaken. At this time, there is limited information available about the quantity of each recovery action that will be undertaken. As discussed later in the report, there is also limited information about the extent to which each class of recovery recommendation will be achieved through increased enforcement or voluntary actions (in which case the fiscal cost of the action is born by private actors), and the extent to which each class of recovery action will be achieved through payments to landowners and other resource managers (in which case the fiscal cost of the action is born by the public sector). Maximum flexibility has been built into these spreadsheet models so that, as additional information about the scale at which recovery recommendations will be undertaken becomes available, more accurate estimates of the aggregate cost of recovery can be made easily and quickly.

The calculation of aggregate costs from unit costs also requires identification of ways in which unit costs are likely to vary systematically across HU/HSAs. A major source of variation is likely to come from regional differences in wage rates since labor costs form a large part of the total unit cost of most recovery recommendations.[1] Data on average wages paid to construction workers in California counties were used to identify how recovery costs are likely to vary across HSAs as a result of labor costs. The economists mapped the county-level wage data to HSAs using GIS results provided by the Department.[2]

Table F-1 reports average construction wages, by county, in regions covered by the Recovery Strategy. These data show that wages vary by as much as 25 percent across counties, and thus across HSAs in which coho salmon recovery activities will take place. Wages are higher in more urbanized counties located near the Bay Area or the Central Coast than they are in more rural counties in Northern California.

To calculate the aggregate fiscal cost of each type of recovery action, by HU, ESU, and state-wide, the following steps were taken:

Step 1: Illustrative project costs for each class of recovery action were identified by examining unit costs of activities that must be undertaken as part of the recovery action and by surveying evidence on historical project costs;

Step 2: As appropriate, ways in which recovery action costs are likely to vary systematically were identified (e.g., in-channel restoration is likely to be more costly at more remote streams);

Step 3: The extent to which differences in wage rates will affect recovery action costs in each HSA was identified using the wage information presented in Table F-1;

Step 4: Base-case assumptions about the quantity of each type of recovery action that will be required in each HSA (e.g., the fraction of stream miles needing riparian revegetation or LWD placement, or the fraction of roads needing decommissioning) were made drawing on information received from the Department, members of the recovery team, and previous literature as appropriate;

Step 5: Using the HSA-specific unit costs developed in steps 1-3, unit costs were multiplied by the HSA-specific recovery action quantities developed in step 4;

Step 6: Total costs for each recovery action by HSA were summed to develop aggregate cost estimates for each HU, ESU and the state as a whole.

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[1] The remoteness of the job site is another factor that influences the cost of a particular recovery project. In some cases, we are able to use cursory information about the distance of a project from a road to incorporate this factor into the analysis.

[2] For HSAs that fall in more than one county, wages are assumed to be a simple average of the wages in all counties covered.

Table F-1: Average 2002 construction industry wages by county

| County | Average Construction wage ($/hour) | County wage as percentage of California average wage (%) |
|---|---|---|
| Alameda | 23.72 | 120 |
| Contra Costa | 23.72 | 120 |
| Del Norte | 18.06 | 92 |
| Glenn | 18.06 | 92 |
| Humboldt | 18.06 | 92 |
| Lake | 18.06 | 92 |
| Marin | 24.80 | 126 |
| Mendocino | 19.03 | 97 |
| Napa | 22.89 | 116 |
| San Francisco | 24.80 | 126 |
| San Mateo | 24.80 | 126 |
| Santa Clara | 23.13 | 117 |
| Santa Cruz | 20.29 | 103 |
| Siskiyou | 18.06 | 92 |
| Sonoma | 20.53 | 104 |
| Solano | 22.89 | 116 |
| Trinity | 18.06 | 92 |
| All CA counties | 19.69 | |

Source: California Office of Employment Statistics, employment and wages by occupation. Available: http://www.calmis.ca.gov/file/occup$/oes$.htm

### F.2.2 TIMING OF RECOVERY RECOMMENDATIONS

Fiscal cost impacts of the various recovery recommendations are presented in the simplest possible terms: the current dollar cost of completing the action now. Absent information about the specific sequencing of recovery recommendations over the coming decades, and lacking information on how state obligations would be financed, it is impossible to calculate financing costs, or to convert actions over some period of time into current dollar equivalents. Instead, costs were calculated as if all recovery recommendations would be completed immediately.

Stretching recovery recommendations over some time period would have at least three effects on current dollar costs of the Recovery Strategy. First, inflation would drive up the nominal costs of all actions. Second, discounting to present values would decrease the lump-sum amount of money needed to finance recovery over some period of time. Third, if recovery were financed by a bond issued up front, then the state would incur financing costs since bondholders would have to be paid yields in excess of the return on allowable investments.

The cost of achieving interim recovery goals is likely to include the cost of most of the biological and non-biological studies and watershed planning exercises called for in the Recovery Strategy. Other interim costs will include the cost of implementing restoration recommendations in the highest priority watersheds. While these watersheds have been identified, the most important recovery recommendations within these watersheds have not been identified at a sufficiently disaggregated level to separately identify these costs. Thus, further quantification of the cost of achieving interim recovery goals is not possible at this time.

### F.2.3 FISCAL COSTS VS. SOCIOECONOMIC IMPACTS

For each of the classes of recovery recommendations considered in this section, the fiscal cost of the action and, separately, the socioeconomic impacts of the action are addressed. The fiscal or budgetary cost of a recovery action is the expenditure needed to physically perform the action. The socioeconomic impact of a recovery action includes (1) income foregone because the recovery action is undertaken and (2) transfers to the local region (in this case, the HSA) from outside the region because the recovery action is undertaken.

Consider the example of riparian revegetation. The fiscal cost of this action is the expenditure required to purchase, plant, and maintain appropriate vegetation in streamside areas. Income may be foregone as a result of this action because land is now devoted to recovering salmon populations. If riparian areas that once provided income from timber harvesting are left to maintain riparian cover for coho salmon, the stream of foregone profits from timber harvesting is an element of the social cost of this recovery action. Tax revenue is also forgone because land is now devoted to maintaining salmon populations. The benfits to landowners of avoiding the loss of land to ongoing erosion is not accounted for.

The welfare costs of recovery recommendations are distinct from the regional transfers associated with recovery recommendations that complete the calculation of socioeconomic impacts. Regional transfers arise when employment or other economic activity occurs in a particular region as a result of a recovery action that otherwise would have taken place in another region. To continue with the example of riparian revegetation, undertaking this recovery action in a particular HSA generates jobs and other economic activity in that HSA, but this activity is not a net gain for the state of California; it is a transfer of economic activity from one region to another. Resources dedicated to riparian revegetation would have been put to another use if the Recovery Strategy were not implemented. Each class of recovery action has analogous socioeconomic impacts, though the magnitude of these transfers varies.

Socioeconomic impacts, in the form of employment effects and other changes in regional economic activity, can be positive or negative. An example of negative socioeconomic impacts arises in the case of water acquisitions. If water is purchased from willing sellers of water rights to increase instream flows for coho salmon, the seller of the water rights is at least no worse off than she would have been if her water rights had been used for production of irrigated agriculture. However, if, as a result of the sale of water rights, agricultural land is left fallow that otherwise would have been used in production, there is an associated decline in demand for agricultural inputs (e.g., fertilizer or pesticide) and a decline in demand for agricultural labor. This economic activity will not take place in the region as a result of the implementation of the Recovery Strategy.

If the State of California, or individual regions covered by the Recovery Strategy, were in a state of full employment, the generation of economic activity as a result of Recovery Strategy implementation could increase the demand for labor and increase equilibrium, or prevailing, wage rates. In general, the economists consider this to be unlikely in the case of the Recovery Strategy. The cost of the Recovery Strategy is small relative to total economic output in the state, and, more importantly, most of the regions in which the bulk of the recovery recommendations will take place face structural unemployment.

Table F-2 summarizes California unemployment rates in 2002 by county and also presents information on whether particular counties have been identified as labor surplus areas by the US Department of Labor. With the exception of urbanized counties in the Bay Area, the unemployment rates in counties containing coho salmon HSAs are above the state average. Almost one-half of these counties have been identified to be labor surplus areas by the US Department of Labor.

Table F-2: California unemployment rates by county

| County | Unemployment rate (%) | Labor surplus area? |
|---|---|---|
| Alameda | 6.8 | |
| Contra Costa | 5.2 | San Pablo City only |
| Del Norte | 9.2 | YES |
| Glenn | 10.2 | YES |
| Humboldt | 6.5 | YES |
| Lake | 8.4 | YES |
| Marin | 4.0 | |
| Mendocino | 7.2 | YES |
| Napa | 4.3 | |
| San Francisco | 7.3 | |
| San Mateo | 5.0 | |
| Santa Clara | 8.4 | |
| Santa Cruz | 8.0 | Watsonville City only |
| Siskiyou | 9.8 | YES |
| Sonoma | 4.5 | |
| Solano | 5.5 | |
| Trinity | 9.6 | YES |
| All CA counties | 6.7 | |

Source: California Office of Employment Statistics, monthly labor force for counties, 2002 benchmark. Available: www.calmis.ca.gov/file/lfhist/02aacou.txt. Labor surplus areas 2003 defined by US Dept. of Labor as areas with unemployment rates above 6 percent for Jan. 2000-Dec. 2001. Available: www.uses.doleta.gov/pdf/lsajurisdictions03.pdf.

Labor surplus areas are defined as areas with unemployment rates above six percent for two years. Thus, this designation is a good indicator of long-term unemployment. Increasing economic activity in a labor surplus area by transferring resources from outside the region to area will be unlikely to increase wages at the margin.[3] By the same logic, wages are also unlikely to be affected by transferring resources from the area (as in the water acquisition example above) to another region.

To calculate the aggregate socioeconomic impacts of commonly-recommended recovery recommendations, steps similar to those outlined for aggregate fiscal costs above were followed. This implies that limited information about the scale or quantity of each recovery action is an important constraint in making this calculation, just as it is in the case of the calculation of aggregate fiscal costs.

The following steps summarize the calculation of socioeconomic impacts in each HSU, HU and statewide:

Step 1: The fraction of illustrative project costs (identified in the course of calculating the fiscal cost of recovery recommendations) attributable to permitting, planning, and mobilization were estimated. These expenditures do not generate appreciable economic activity or employment in local regions;

Step 2: Regional transfers were estimated as total fiscal costs for each recovery action by HSA less the fraction of these costs identified in Step 1.

Step 3: Welfare impacts associated with each class of recovery action were identified; where possible, these impacts were quantified by multiplying unit social costs (or benefits) by the amount of each recovery action that would be undertaken.

Step 4: Tax impacts associated with each class of recovery action were identified; where possible, these impacts were quantified by multiplying unit costs (or benefits) by the amount of each recovery action that would be undertaken.

Step 5: Impacts calculated in Steps 2-4 were summed to develop aggregate socioeconomic impact estimates for each HU, ESU and the state as a whole.

## F.3 BARRIERS TO FISH PASSAGE

In many HUs and HSAs, assessment, prioritization, and treatment of barriers to fish passage have been identified as recovery priorities. Assessing the cost of these activities requires information about (1) the inventory of barriers in each HSA, (2) the location of barriers in HSA, and (3) the size or complexity of all barriers. In this section the cost of projects to treat each of these types of barriers is discussed. To estimate the cost of treating barriers, the Department

[3] Note that if volunteer labor is used for restoration activities this can reduce the fiscal costs of these activities. It does not change the way the socioeconomic impacts are calculated. These are still correctly calculated using market wage rates on the assumption that this wage is foregone when volunteers supply their labor for restoration, just as it is foregone when leisure is chosen over labor.

supplied an inventory of potential barriers by HSA. This inventory database includes a description of the barrier, information (if known) about whether the barrier constitutes a total, partial, or temporal (seasonal) barrier to fish passage, and information, developed using GIS, about whether the barrier is located in a forested, agricultural, suburban, or urban area. It is important to note that this database contains potential barriers and that not all of these potential barriers have been field verified. The Department has identified the following types of potential barriers[4]:

- Dams;
- Non-structural sites (e.g., log jams);
- Fish passage facilities;
- Stream crossings (e.g., culverts);
- Unknown/Other barriers; and
- Water diversions.

## F.3.1 FISCAL COSTS

### F.3.1.1 Dams

The Department has identified by HU dams that could act as potential barriers to fish passage in the coho salmon ESUs. There are at least two major actions that can be taken to improve fish passage at dams; the dam can be removed (more likely to be feasible in the case of small dams) or ladders, screens, and pumps can be installed to allow fish to pass over the dam.[5] The fiscal cost of either of these actions varies widely and depends on (1) the physical location of the barrier, (2) the height of the barrier, and (3) the width of the barrier. The barrier inventory supplied by the Department does not include information about these physical characteristics of dams; information on the height of about 250 of the dams was collected from the National Inventory of Dams[6] and matched with the Department's data using reported dam names.

To estimate the fiscal cost of dam treatment, surveys previously performed by other authors of the cost of fish passage improvement at dams were considered, and indicative project costs were based on similar project costs in California and, to a lesser extent, in Oregon and Washington.



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4 Barriers information provided by the Department comes from the State Coastal Conservancy (SCC) Report of Potential Barriers to Fish Passage (Bowen et al, Report to the Legislature, 2003).

5 New fish ladders may be installed or modified to replace poorly functioning ladders that cannot pass fish easily during certain flow conditions. Modified or new fish ladders may have wider flow ranges for passing fish. Locations for new fish ladders would be where construction, operation, and maintenance access are most efficient, usually at stream edges. Potential designs of fish ladders include pool and weir, vertical slot, and roughened channel types. (Source: http://www.delta.dfg.ca.gov/afrp/documents/DeerPEA.pdf

6 Available: http://crunch.tec.army.mil/nid/webpages/nid.cfm.

The cost of removing dams varies fairly regularly with the height and width of the dam, but project-specific factors, such as structure type, sediments, water rights, easements, and the need for monitoring can greatly impact the total cost of treatment (Rhode Island Habitat Restoration Portal (2001).[7] Friends of the Earth et al. (1999)[8] performed case studies of more than 30 dam removal projects in the United States and found that some small dams can be removed for under $10,000. The removal of a larger dam (e.g., 15-20 feet in height) can cost as much as $1 million. In neither case do these cost estimates include the important considerations of the cost of permits, easements, design, or monitoring. The median cost of dam removal in this study was about $100,000. However, this finding cannot be interpreted to suggest that this will be true in California or elsewhere in the future. Previous dam removals were not the result of a random selection; it is likely that relatively inexpensive removal projects have been undertaken first and that average removal costs will rise over time.

As in the case of dam removal, the cost of constructing an artificial fishway is proportional to the height of the dam or other obstruction. Rhode Island Habitat Restoration Portal (2001) and Connecticut River Watershed Council, Inc. (2000)[9] show illustrative fishway construction costs for two commonly used fishways, steeppass and denil. These findings show that installation of steeppass fishways, which can be used for dams up to 12 feet in height, costs about $10,000 for every vertical foot of dam height. When dam height exceeds eight or nine feet, a resting pool should be added, which costs another $5,000. A denil fishway, used for larger dams, costs about $20,000 for every vertical foot for dams up to six feet in height. For higher dams, denil fishways cost about $25,000 to $30,000 for every vertical foot. These costs also apply to projects to improve passage at the 37 fish passage facilities identified by the Department in its barrier inventory.

A survey of recent expenditures on projects to remove dams or improve fish passage at dams in California undertaken by the authors is broadly consistent with the findings of surveys in other parts of the United States. For example, removal of the four water diversion dams, varying in height from six to twelve feet, along Butte Creek cost about $9.18 million in 1998 (12 unscreened diversions were also treated). This suggests an average dam removal cost of about $2 million. Removal of the Lake Christopher dam (10 feet in height and 400 feet in length) cost about $100,000 in 1994. At the time, repair costs to improve fish passage were estimated at $160,000 to $180,000. Both of these projects are described in detail by American Rivers (1999)[10]. The Fife Creek Check Dam Removal and Habitat Enhancement Project in Sonoma

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[7] Rhode Island Habitat Restoration Portal. 2001. Restoring coastal habitats for Rhode Island's future: Costs of restoration. Available: http://www.edc.uri.edu/restoration/html/tech_sci/socio/costs.htm

[8] Friends of the Earth, American Rivers, Trout Unlimited. 1999. Dam Removal Success Stories: Restoring Rivers Through Selective Removal of Dams that Don't Make Sense. Available: http://www.americanrivers.org/damremovaltoolkit/ssoverview.htm

[9] Connecticut River Watershed Council, Inc. 2000. Providing fish passage around dams in the Northeast: a fishway for your stream. The Connecticut River Watershed Council, Inc., Easthampton, Massachusetts.

[10] American Rivers. 1999. Completed Dam Removals in California. Available: http://www.americanrivers.org/damremovaltoolkit/sscalifornia.htm.

County, which was funded by the Department in 1999, cost about $54,000.[11] The economists reviewed ther projects recently funded by the Department to improve fish passage at dams by installing ladders and pumps and they found that costs ranged from $150,000 to $1.6 million, with a mean cost of about $900,000. [12]

Based on this information about recent projects, the following assumptions were made in calculating the total expected cost of dam removal and treatment in the coho salmon ESUs :

1. Dams smaller than 15 feet in height will be removed if treated.
2. The average cost of removing a small dam (less than 15 feet) in this region is $500,000.
3. For dams of known height greater than 15 feet, treatment costs will be $15,000 per foot.
4. For dams of unknown height that have been identified as complete barriers to fish passage, the cost of treatment will be $900,000.
5. For dams of unknown height that have been identified as partial and/or temporal barriers to fish passage, or barriers of unknown magnitude, the cost of treatment will be $450,000.

The Bureau of Reclamation (BOR) assumes that indirect costs, including permitting, account for about 40 percent of total project costs for upgrading and installing fish screens (Hudson 2002).[13] The assumumption was made that this fraction of project costs will be spent on permitting and other indirect costs for all barriers projects except culvert treatment. This fraction of total unit costs is not expected to vary by HSA. Of the remaining costs, the assumption was made that 15 percent are attributable to labor, consistent with the other culvert replacement itemized budgets (see the discussion of stream crossings in section F.3.1.3). This fraction of costs (about nine percent of project costs) will vary by HSA according to local wage rates.

Based on advice received from the Department, the assumption was made that approximately 50 percent of the potential barriers to fish passage that are dams will require treating except in those HUs where the Department has more precise information about the number of dams that act as barriers. Attachment 1 summarizes the estimated aggregate cost of dam treatment by HU.

### F.3.1.2 Non-structural sites

Non-structural barriers such as log-jams, boulder jams, and other barriers of natural materials can impede fish passage in ways similar to dams. The Department has identified over 3,000

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[11] State of California Department of Fish and Game Native Anadromous Fish and Watershed Branch. 2000. Summary of projects funded in 1999. Available: http://www.dfg.ca.gov/nafwb/1999grants.htm.

[12] State of California Department of Fish and Game Native Anadromous Fish and Watershed Branch. Summary of projects funded in various years. Available: http://www.dfg.ca.gov/nafwb. See also California Department of Water Resources, Bulletin 250-2002, Fish passage improvement. Available: http://www.isi.water.ca.gov/fish/ChapterFront/Front%20Matter.pdf

[13] Hudson, R.D. (2002), Upgrading and installing fish screens: Developing cost estimates. In S. Allen, R. Carlson, and C. Thompson (eds.), Proceedings of the salmon habitat restoration cost workshop. Pacific States Marine Fisheries Commission. Gladsone, OR.

non-structural barriers and almost 100 other sites that are similar (e.g., trash or tires blocking streams). Unlike many dams, most non-structural sites can be removed or altered to allow fish passage. The cost of barrier removal can vary depending on the location of the barrier, permitting requirements, and sediment impacts of removal. Direct removal costs generally depend on the sheer size of the site to be altered reports. Table F-3 presents illustrative unit costs for activities to be undertaken when non-structural sites are treated. These costs reflect state-wide averages as calculated by the United States Department of Agriculture (USDA) in Oregon as part of its Environmental Quality Incentives Program (EQIP) program.[14]

The Department's inventory of potential non-structural barriers to passage does not include information on the size of the barriers. Thus, to estimate the approximate size of the non-structural barriers to passage that will be removed information about the cost of previous Department-funded non-structural barrier removal projects was reviewed and a range of relevant projects funded by the Department since 1999 was identified. These projects ranged in cost from $1,600 to $28,000. Based on this information, an average project cost was assumed to be $10,000 for purposes of calculating the total cost of non-structural barrier removal.

Table F-3: Construction unit costs for treatment of non-structural sites in Oregon

| Activity | Unit cost ($) | Unit |
|---|---|---|
| Rock excavation | 7.5 | CY |
| Wet excavation | 1.75 | CY |
| LWD removal | 125 | ton |
| Log removal | 100 | ton |
| Rock clearing | 25 | ton |
| Root wad removal | 100 | ton |

Source: USDA EQIP Program (2002)
Units: LF: linear foot, CY: cubic yard, SF: square foot.

BOR calculates that indirect costs, including permitting, account for about 40 percent of total project costs for upgrading and installing fish screens (Hudson 2002). The assumption was made that this is indicative of the fraction of project costs that will be spent on permitting and other indirect costs for all barriers projects. This fraction of total unit costs will not vary by HSA. Of the remaining costs, 15 percent were assumed to be attributable to labor, consistent with some actual itemized budgets for culvert replacement(see the discussion of stream crossings in section F.3.1.3). This fraction of costs (about 9 percent of project costs) will vary by HSA according to local wage rates.

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14 It appears that this class of recovery action has not been funded by EQIP in California yet. Project costs are likely to be similar.

On the advice of the Department, impact calculations assumed that approximately 50 percent of the potential barriers to fish passage that are non-structural sites will require treating. Attachment 1 summarizes the estimated aggregate cost of non-structural site treatment by HU.

#### F.3.1.3 Stream crossings

Many existing culverts, built at a time when concerns about fish passage were less prevalent than they are currently, are now recognized as potentially important targets of the Recovery Strategy because older culverts can block access to reaches of potential habitat. Replacing culverts involves removal of old-style culverts (often large pipes) at stream crossings and replacing them with structures that fish can pass through more easily, such as concrete arch or box culverts. The surrounding road segment must be rebuilt. Table F-4 presents information on the unit cost of construction elements of culvert treatment in California.

Culvert replacement can be a complex and costly activity. Non-construction activities, not included in Table F-4, can account for a significant fraction of the total costs. As an illustration of the non-construction costs that are important parts of culvert replacement activities, Table F-5 presents itemized budgets for several culvert replacement and repair projects in Washington State.[15] Notably, traffic control and pre-project mobilization, (which includes permitting) are major elements of total project costs. This is likely to be less important for forest roads, but at least 20 percent of the culverts potentially needing replacement in the coho salmon ESUs are not associated with forest roads, but other more heavily trafficked county and city roads. Costs are also likely to differ depending on whether private landowners or the public sector performs culvert replacement. Costs may be higher for the public sector.

Table F-4: Construction unit costs for treatment of stream crossing barriers to passage in California

| Activity | Unit Cost ($) | Units |
|---|---|---|
| Arch culverts | 32.8 | LF-Diameter/LF |
| Non-structural non-reinforced concrete | 150 | CY |
| Non-structural reinforced concrete | 250 | CY |
| Earthwork excavation | 1.5 | CY |
| Geoweb/Geocell soil cellular confinement system | 5 | SF |
| Gravel, in place | 18 | CY |
| Rock, in place | 100 | CY |
| Constructing step-pool/ weir below culvert | 2,000 | LF |

Source: USDA EQIP Program (2002) Available: http://waterhome.brc.tamus.edu/NRCSdata/Costs/, California Department of Transportation (Caltrans) personal communication (step-pool/ weir construction).
Units: LF: linear foot, CY: cubic yard, SF: square foot.

[15] These cost estimates come from winning bidders responding to requests from the Department of Transportation. In Caltrans' experience, item-by-item cost data are skewed by the bidding process. Bidders have incentives to present estimated costs that differ from their actual costs as part of the effort to be the lowest bidder (Personal Communication, Recovery Team). Thus, these figures must be interpreted with care.

Table F-5: Illustrative project costs for treatment of stream crossing barriers to passage in Washington State

| Project | | Culvert replacement ($ '000) | | Culvert repair ($ '000) |
|---|---|---|---|---|
| County | King (suburban) | Snohomish (rural) | Whatcom (rural) | Chelan (rural) |
| Activity | | | | |
| Mobilization | 46 | 50 | 8 | 16 |
| Structure/obstruction removal | 7 | 8 | 1 | 1 |
| Grading | 8 | 23 | 3 | |
| Culvert drainage | 259 | 128 | 8 | 150 |
| Surfacing | 14 | 20 | 1 | |
| Pavement | 21 | 11 | 2 | |
| Erosion control/ planting | 38 | 16 | 24 | 1 |
| Traffic control | 236 | 250 | 15 | 40 |
| Other miscellaneous | 8 | 24 | 13 | 12 |
| Total cost | 637 | 530 | 75 | 220 |

Washington State Dept of Transportation Bid Check Reports, engineering estimates. http://www.wsdot.wa.gov/biz/contaa/BIDTAB/. Snohomish culvert replacement project included an additional pavement installation element costing about $228,000 not included here. Thus, traffic control costs associated with culvert replacement only are likely less than the costs reported here.

The total fiscal cost of culvert replacement activities depends on (1) the type of the road that crosses the stream, (2) the size of the waterway crossed, and (3) whether the land where the culvert is located is privately or publicly owned. Evergreen Funding Consultants (2003) surveyed culvert replacement projects and found that while culvert replacement on forest roads costs between $15,000-$40,000 on a small waterway less than ten feet wide, it can cost as much as $100,000 to replace a forest road culvert at a tributary between ten and 20 feet wide and $150,000 to replace a forest road culvert at a tributary over 20 feet wide. These project cost estimates include the cost of construction, permitting, and traffic control.[16] For non-forest roads, Table F-6 summarizes Evergreen Funding Consultants' findings.

Information provided by Caltrans to the CRT is consistent with the information provided in Table F-6. Caltrans reports that culvert replacement, with no change in flow capacity, can range in cost from $20,000 to over $1 million. Replacement with an upgrade in flow capacity and improvements in culvert slope ranges in cost from about $30,000 to $2 million. Caltrans projects an average cost of about $400,000 for replacement in the coho salmon range since most fish culverts are either box culverts or large circular culverts. For culvert rehabilitation, Caltrans

[16] According to the Highway Construction Cost Comparison Survey performed by the Washington State DOT (2002), preliminary engineering costs are about 5 percent higher in California than they are in Washington. However, environmental mitigation costs are generally lower in California. In total, illustrative highway construction costs (for a Diamond interchange) are about 40 percent higher in California than they are in Washington. The survey does not identify the source of this variation.

estimates that costs range from $15,000 to $500,000; with an average cost of about $100,000 if no added effort is made to improve fish passage. If rehabilitation addresses fish passage concerns only, project costs average about $80,000. Caltrans cost estimates are probably indicative of the costs that counties will face as well.

Table F-6: Estimated cost of culvert treatment by road type ($ '000)

| | Road Type | | |
|---|---|---|---|
| Size of waterway | Two-lane road (minor) | Two-lane road (major) | Highway |
| Less than 10 feet | 50-100 | 100-200 | 200-350 |
| 10-20 feet | 140-240 | 200-350 | 300-450 |
| 20-30 feet | 180-280 | 250-450 | 600-800 |
| Source: Evergreen Funding Consultants (2003) | | | |

In the event that culverts are to be replaced with span bridges, project costs will likely be much higher (Caltrans personal communication, Evergreen Funding Consultants, 2003). This depends on the span of the waterway in question; for larger waterways, culverts may have to be cast in place; in that event the cost of bridges and culverts will be similar. If bridges are used in instances in which a pre-cast culvert might be available, the incremental cost associated with the choice of a bridge can be on the order of $300,000 (Caltrans personal communication).[17]

When estimating the cost of culvert treatment in practice, it will be important to consider local labor costs, since traffic control is a labor-intensive activity, as well as the location of culverts and waterway size. The itemized budgets for the culvert replacement projects in Washington State reviewed by the economists suggest that traffic control labor represents about 20 percent of total traffic control costs. Itemized budgets from Oregon suggest that construction labor costs are about 12 percent of total construction costs (Medford District Resource Advisory Committee Project number 118-409).

Based on estimates made by Evergreen Funding Consultants (2003) and review of culvert replacement and repair projects in California, Washington, and Oregon, the costs of culvert treatment are expected to vary according to the geographic location of culverts, the extent to which stream crossings constitute partial/temporal or total barriers, and waterway size as summarized in Table F-7. To estimate the cost of treating stream crossings in the coho salmon



[17] Whether a culvert receives remediation treatment vs. a full replacement not only depends on type and timing of impediment, but most importantly on size and condition of original culvert and ease of full replacement. For example, a large box culvert on Sir Francis Drive Road in West Marin, with another 30 years of wear, and huge costs and inconveniences associated with traffic control, would more likely receive an interior structural fix (e.g. baffles and step pool construction), vs. a full replacement. Often, the Capital Improvements Projects schedule and budget of a government entity such as a county or city, highly influences the type of project (FishNet 4C Program public comment).

ESUs, it is necessary to contend with the fact that no data are available in the Department's inventory of potential barriers about the size of the culverts that have been identified as potential barriers to fish passage. The barrier inventory does identify whether the culvert occurs at a tributary (a relatively smaller waterway) or a stream (a relatively larger waterway). This information was used to predict how the cost of culvert treatment will vary among barriers. Data were provided by the Department about land use in the area in which culverts have been identified. As discussed above, it is likely that culverts in forest regions are smaller and less costly to treat than culverts in other regions. The traffic control costs in project budgets reviewed by the economists suggest that culverts in suburban and urban areas are likely to be more costly to treat than stream crossings in less-traveled rural or agricultural areas. No data are available about whether culverts that will be treated are on public or private roads. Thus, the explicit costs calculations cannot take potentially higher public sector costs into account. However, unit cost estimates are informed by surveys of both public and private costs.

Table F-7: Cost per project to provide fish passage/ mitigate barrier at stream crossings ($ '000)

| Stream Crossing | Land-use where stream crossing located | | | |
|---|---|---|---|---|
| | Forest | Agriculture | Suburban | Urban |
| Tributary | | | | |
| Total barrier | 56 | 140 | 280 | 490 |
| Partial/ temporal barrier | 28 | 70 | 140 | 245 |
| Stream | | | | |
| Total barrier | 140 | 336 | 490 | 700 |
| Partial/ temporal barrier | 70 | 168 | 245 | 350 |

Source: See text. Some potential barriers are of unknown severity. The conservative assumption has been made that these constitute total barriers to passage.

BOR assumes that indirect costs, including permitting, account for about 40 percent of total project costs for upgrading and installing fish screens. (Hudson 2002). It was assumed that this is indicative of the fraction of project costs that will be spent on permitting and other indirect costs for all barriers projects. This fraction of total unit costs will not vary by HSA. Of the remaining costs, the assumption was made that 15 percent are attributable to labor, consistent with the culvert replacement itemized budgets that were reviewed. This fraction of costs (about nine percent of total project costs) will vary by HSA according to local wage rates.

Based on advice provided by the recovery team, a review of the Marin County Stream Crossing Inventory and Fish Passage Evaluation (Ross Taylor and Associates 2003) and a review of the Inventory of Select Migration Barriers in the San Geronimo sub-watershed[18], this analysis assumes that approximately 50 percent of the potential barriers to fish passage that are stream crossings will require treatment for coho salmon recovery. For each HSA, the fraction of

[18] Prepared by the Salmon Protection and Watershed Network (2002). Available: http://www.spawnusa.org/reports/Mig_Bar_Rpt_10-10-02.pdf.

treatment that will be culvert rehabilitation, as opposed to replacement, depends on whether the barriers identified in the HSA are partial and/or temporal barriers as opposed to total or unknown barriers. With no basis to identify when span bridges may be appropriate, the assumption was made that culvert rehabilitation and treatment will be used. Attachment 1 summarizes the estimated aggregate cost of stream crossing treatment by HU.[19]

### F.3.1.4 Fish passage facilities

The Department has identified 45 fish passage facilities in the coho salmon ESUs that may constitute barriers to passage, presumably because the pumps, fish ladders, and screens at these facilities require repair or upgrades.

To estimate the cost of improving fish passage at these facilities, the economists reviewed the cost of projects funded by the Department recently to repair and upgrade fish ladders and install pumps and screens. For these eight recent projects, costs for repairing and upgrading fish passage at facilities ranged from around $60,000 to over $1.6 million. On average, the cost of treatment for this type of barrier was $760,000.[20] The assumption was made that costs on larger waterways (streams) will be slightly greater than this ($900,000) and costs on smaller waterways (tributaries) will be lower ($500,000).

BOR assumes that indirect costs, including permitting, account for about 40 percent of total project costs for upgrading and installing fish screens. (Hudson 2002). The assumption was made that this is indicative of the fraction of project costs that will be spent on permitting and other indirect costs for all barriers projects. This fraction of total unit costs will not vary by HSA. Of the remaining costs, the assumption was made that 15 percent are attributable to labor, consistent with the culvert replacement itemized budgets that have been reviewed. This fraction of costs (about nine percent of total project costs) will vary by HSA according to local wage rates.

On the advice of the Department, the assumption was made that approximately 50 percent of the potential barriers to fish passage that are fish passage facilities will require treatment for coho salmon recovery. Attachment 1 summarizes the estimated aggregate cost of stream crossing treatment by HU.

### F.3.1.5 Water diversions

The Department has identified approximately 1,100 locations where water is diverted from streams for agriculture, domestic, or industrial uses through unscreened intakes in the coho salmon ESUs. The majority of these diversions are for irrigation purposes. Fish screening

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[19] For a limited number of culverts, precise treatment cost estimates have been provided by the Department. These culverts are in the Klamath River HU, Eel River HU and Scott River HA.

[20] State of California Department of Fish and Game Native Anadromous Fish and Watershed Branch. Summary of projects funded in various years. Available: http://www.dfg.ca.gov/nafwb. See also California Department of Water Resources, Bulletin 250-2002, Fish passage improvement. Available: http://www.isi.water.ca.gov/fish/ChapterFront/Front%20Matter.pdf

devices can be placed at these diversions to prevent fish from entering the diversion and being lost. Water continues to pass as needed, but fish cannot leave the stream.  USDA has estimated the average cost of fish screen installation in California as relatively modest. These cost estimates are summarized in Table F-8.

Table F-8: Construction unit costs for fish screen installation in California

| Device | Units | Unit cost ($) |
|---|---|---|
| Fish Screen - Passive | Each | 1,000 |
| Fish Screen - Self Cleaning | Each | 3,000 |
| Fish Screen - Large | Each | 40,000 |
| Fish Screen - Small | Each | 10,000 |

Source: USDA EQIP Program (2002)
http://waterhome.brc.tamus.edu/NRCSdata/Costs/

Actual projects undertaken or proposed in Washington State report costs that are similar to these average cost estimates provided by USDA. For example, a proposal submitted to the Columbia Basin Fish and Wildlife Authority in 2001 proposed to install passive fish screens at all Walla Walla Basin irrigation diversions (197 diversions in total) at a total cost of about $1 million. The physical cost of the screens was estimated to be about $2,300 each, including a 15 percent cost share from land owners.[21] Field assessments were estimated to cost about $30,000 or about $150 per diversion. There are likely to be significant economies of scale associated with the assessment requirements of water diversions. That is, these associated costs are likely to be lower on a per unit basis when many diversions are to be screened.

To take another example, a project proposal for the fabrication and installation of two new fish screening facilities and the rehabilitation of one existing screening facility on irrigation diversions on the Wentachee River in 2003 estimated a construction cost of $45,000.[22] Screening costs are higher on larger bodies of water than small ones. Based on this review, when the aggregate costs of water diversion treatment is calculated, the assumption was made that barriers on relatively small tributaries can be treated at a cost of $10,000, and barriers on relatively larger stream can be treated at a cost of $40,000.

BOR assumes that indirect costs, including permitting, account for about 40 percent of total project costs for upgrading and installing fish screens. (Hudson 2002). The assumption was made that this is indicative of the fraction of project costs that will be spent on permitting and other indirect costs for all barriers projects. This fraction of total unit costs will not vary by HSA. Of the remaining costs, the assumption was made that 15 percent are attributable to labor, consistent with the culvert replacement itemized budgets reviewed by the economists (see the

[21] CBFWA FY 2001 Project ID 23048. Available: www.cbfwf.org/2001/highpriority/projects/23048.htm.
[22] CBFWA FY 2001 Project ID 29028. Available: http://www.cbfwf.org/files/province/cascade/projects/29028.htm.

discussion of stream crossings in section F.3.1.3). This fraction of costs (about nine percent of total project costs) will vary by HSA according to local wage rates.

On the advice of the Department, the assumption was made that approximately 50 percent of the potential barriers to fish passage that are diversions will require treating. Attachment 1 summarizes the estimated aggregate cost of diversion treatment by HU.

### F.3.2 SOCIOECONOMIC IMPACTS

As discussed in section F.3.1, for each category of barriers, a review of historical barrier treatment projects provides the information necessary to estimate the fraction of project costs attributable to permitting, planning, and mobilization. The socioeconomic impact in the form of regional transfers that will occur as a result of barrier treatment was calculated to be total fiscal costs less that fraction. Estimated socioeconomic impacts as a result of these transfers are summarized in Attachment 1.

Other welfare impacts associated with barrier removal are more difficult to quantify because of the limited information available about which potential barriers will actually be treated as a result of implementation of the Recovery Strategy. These impacts can only be discussed qualitatively at this time.

Dam removal may result in third-party impacts if dams currently serve a useful economic or recreational purpose. The benefits that these dams currently provide would be lost in the event that dams were removed to improve passage for coho salmon. Culvert replacement or treatment may increase or reduce flooding and associated costs. Screening water diversions and improving fish passage facilities should result in few substantive social costs, though maintenance requirements will result.

## F.4 RIPARIAN REVEGETATION AND STREAM BANK IMPROVEMENTS

One of the most common recommendations in the Recovery Strategy is riparian revegetation, accomplished by planting trees along stream and tributary banks to provide shade over the water that coho salmon use. These efforts are often part of larger projects to improve the condition of stream banks, including fencing and channel stabilization. This section considers the cost of riparian revegetation and more general stream bank improvements.

The recommendations of the CRT with respect to riparian revegetation are fairly general in nature. Currently, information is not available as to the size of the buffer zones that the CRT believes are required at different types of streams. Similarly, information is not available to estimate the number of stream miles that require revegetation or other types of streambank improvements and the physical location of sites needing treatment. Given the general nature of the recommendations, the estimates of aggregate costs and socioeconomic impacts are necessarily sensitive to assumptions made about the values of these parameters.

## F.4.1 FISCAL COSTS

### F.4.1.1 Riparian revegetation

The fiscal costs of riparian revegetation or planting depend on (1) the complexity of the project to be undertaken (e.g., the materials to be used), (2) the remoteness of the parcel of land to be treated, and (3) the degree of site preparation that is needed. Evergreen Funding Consultants (2003) suggest a budget of between $5,000 per acre and $135,000 per acre, with higher costs for projects that involve larger trees, more heavy machinery, and limited accessibility. These estimates include the cost of permitting and several years of maintenance. Notably, federal government support for riparian revegetation projects in California under the EQIP program provides 50 percent cost-sharing assuming a cost of implementation of $2,000 per acre, significantly lower than the cost of typical programs in Washington State surveyed by Evergreen Funding Consultants. [23]

The complexity of riparian revegetation projects depends on whether planting is part of a larger set of stream bank protection and improvement activities, which can vary widely in cost depending on site-specific goals and needs. The next subsection discusses the average unit cost of typical stream bank improvement activities in California.

Site preparation costs depend significantly on the slope of the land being planted and the amount of clearing required. Evergreen Funding Consultants (2003) report that for medium-cost projects, as defined by materials used and site accessibility, revegetation on flat and fairly clear sites cost between $10,000 and $30,000 per acre. Projects on steep sites where significant clearing is required will cost around $100,000 per acre. Clearly, determining whether a riparian revegetation project will be cost-effective depends significantly on the site type. Determining the aggregate cost of riparian revegetation also depends on the site types in each HSA, but no information is available about this in the Recovery Strategy.

High-cost riparian revegetation projects, in terms of materials used and site accessibility, have certainly been undertaken in other regions with endangered salmonid populations. If regulators and/or landowners want to provide drastic and rapid improvements in shade at streams and creeks, one option is to transplant large trees. For example, at the Stables Creek reconstruction project in Snohomish County, Washington, 15-20 foot high trees were planted at the streambank. Using volunteer labor and donated material is more likely to make this sort of project cost-effective from the perspective of public agencies.

Riparian revegetation projects also vary in cost according to site accessibility. The Department has provided information about the distance of streams in each HSA from roads. Riparian revegetation at sites further from roads is likely to be more costly than at sites near roads. Evergreeen Funding Consultants (2003) estimate that projects on an average slope, and

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[23] The cost estimates discussed in this section do not include the potential cost of conservation easements in riparian zones. See section F.4.2.1 for a discussion of the data required to estimate the cost of easements.

requiring average clearing and materials, vary in cost from about $20,000 to $80,000 per acre. For this analysis, the assumption was made that the average cost of riparian revegetation projects will vary as follows:

- Projects at stream area located less that 0.25 miles from a road cost $30,000 per acre;
- Projects at stream area located between 0.25 and 0.5 miles from a road cost $35,000 per acre;
- Projects at stream area located between 0.50 and 1 mile from a road cost $45,000 per acre;
- Projects at stream area located between 1 and 2 miles from a road cost $50,000 per acre;
- Projects at stream area located between 2 and 3 miles from a road cost $55,000 per acre; and
- Projects at stream area located more than 3 miles from a road cost $60,000 per acre.

The assumption was also made that at any stream mile that needs riparian revegetation, the width of the buffer created will be 50 feet. These assumptions result in fairly conservative cost estimates, but this is appropriate in the absence of additional information about the cost of materials required at sites. These parameters can easily be changed when the spreadsheet models provided to the Department are updated.

Riparian revegetation is a fairly labor intensive activity. As discussed in section F.2.1, labor costs largely determine how the cost of recovery actions will vary spatially, controlling for topographical differences among potential project sites. Thus, the labor requirements for projects will partially determine where riparian revegetation is relatively cost-effective. Typical restoration costs estimates reported by Bair (2002) suggest that about three percent of total project costs are due to labor. Because permitting and planning account for 53 percent of total costs, this is a fairly large fraction of total implementation costs. In calculations to estimate the aggregate cost of riparian revegetation, thee assumption was made that three percent of unit costs will vary by HSA.

Attachment 2 summarizes the estimated aggregate cost of riparian revegetation by HU. These cost estimates are developed using estimates of the amount of riparian planting work that will be needed that were provided by the Department, and, in the case of the CCC Coho ESU, total cost estimates by HSA provided by the Department. Where the Department has provided this information at the HU level, the assumption was made that needs are divided among HSAs within an HU equally.[24]



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24 In the SONCC Coho ESU, the Department provided estimates of the quantity of riparian revegetation and stream bank improvements needed that was not disaggregated by distance of streams from roads. Thus, while the spreadsheet model allows the analyst to vary the percentage of stream miles treated by distance from the road, in practice we calculate the aggregate cost of this class of recovery action as though all treated stream miles are less than 0.25 miles from roads. This assumption was made because in practice 60 percent of stream miles in the coho salmon range are within 0.25 miles of a road and over 90 percent are within one mile.

### F.4.1.2 Stream bank improvements

While riparian revegetation can be undertaken in isolation, these planting efforts may also be part of larger projects intended to stabilize and improve stream banks to reduce erosion. Table F-9 summarizes the average unit cost of various stream bank improvement activities in California as reported by USDA.

USDA cost estimates report that stream bank protection projects in general cost about $125 per square foot in California. However, these cost estimates do not include the cost of maintenance or permitting. Evergreeen Funding Consultants (2003) provide project cost estimates that include the cost of permitting and short-run maintenance and range from $30 per foot to $1,000 per foot. More complex projects in more remote areas will be more costly. In addition, projects needing significant excavation and grading will be more costly, as will those located in areas where the width of the stream is greater.

Table F-9: Construction unit costs for stream bank improvement activities in California

| Stream bank improvement activities | Units | Unit cost ($) |
|---|---|---|
| Compacted Fill | CY | 2.5 |
| Cut and filling | CY | 130 |
| Geotextile Fabric | SF | 1.25 |
| Grading and Shaping | AC | 200 |
| Mobilization | Each | 1250 |
| Rock, In Place | CY | 100 |
| Rock/fill | CY | 50 |
| Seedbed preparation | AC | 50 |
| Stream tree revetment | Each | 22 |
| Wildlife Repellant (chemical) | AC | 100 |
| Stream bank protection, general | LF | 125 |

Source: USDA EQIP Program (2002) Available: http://waterhome.brc.tamus.edu/NRCSdata/Costs/

Units: LF: linear foot, CY: cubic yard, SF: square foot, AC: acre.

USDA cost estimates report that stream bank protection projects in general cost about $125 per square foot in California. However, these cost estimates do not include the cost of maintenance or permitting. Evergreeen Funding Consultants (2003) provide project cost estimates that include the cost of permitting and short-run maintenance and range from $30 per foot to $1,000 per foot. More complex projects in more remote areas will be more costly. In addition, projects needing significant excavation and grading will be more costly, as will those located in areas where the width of the stream is greater.

Besides depending on project complexity, the cost of stream bank improvement projects will also depend on the productivity of labor hired for the project and local wage rates. Table F-10 summarizes approximate labor requirements for typical stream bank improvement activities. In general, the larger the vegetation products being planted, the more labor that will required for each stream mile treated. Seeding is much less costly than planting containerized plants or larger trees.

Table F-10: Labor requirements for stream bank improvements

| Activity | Per person labor required |
|---|---|
| Brush layering | 6-17 LF/hr |
| Brush mattress | 0.2-1.2 SY/hr |
| Plant Roll | 20 LF/hr |
| Fascine placement | 5 LF/hr |
| Sprig planting | 5-24 SY/hr |
| Seedling planting | 30-120 plants/hr |
| Ball and Burlap shrubs | 1-158 plants/hr |
| Containerized plants | 20-100 plants/ hr |
| Seeding | 0.05-0.5 AC/hr |
| Hydroseeding | 0.12-0.37 AC/ hr |

Source: Hoag (2000).
Units: LF: linear foot, SY: square yard, SF: square foot, AC: acre.



To calculate the aggregate cost of stream bank improvements, the assumption was made that streambank improvement projects cost including permitting and maintenance are higher than the construction-only costs reported by USDA, and roughly in the middle of the cost estimates reported by Evergreeen Funding Consultants (2003). As discussed in the previous subsection, it is difficult to determine, based on limited available information, how to vary stream bank improvement costs within HSAs except on the basis of site remoteness.[25] The estimated cost of this class of recovery action is about $200 per lineal foot for stream bank area that is less than 0.25 miles from a road. As the distance of the stream bank from a road increases, unit costs are assumed to increase in the following manner:

- Projects at stream area located between 0.25 and 0.5 miles from a road cost $250 per lineal foot;
- Projects at stream area located between 0.50 and 1 mile from a road cost $275 per lineal foot;
- Projects at stream area located between 1 and 2 miles from a road cost $300 per lineal foot;
- Projects at stream area located between 2 and 3 miles from a road cost $325 per lineal foot; and
- Projects at stream area located more than 3 miles from a road cost $350 per lineal foot.

[25] Lack of information about site characteristics across HSAs may explain why these cost estimates are significantly higher than those reported by Hampton (2002) from a survey of 12 erosion control projects in California. He reports average unit costs that are very low compared those that we use here, on the order of $8 per lineal foot.

Costs vary across HSAs according to wage rates. Thee assumption was made that planning and permitting costs account for 53 percent of total unit costs and do not vary by HSA, just as in the case of riparian revegetation. Ideally, costs would also vary by the size of the waterway and extent of excavation needed, but with no information on the number of stream miles where stream bank improvements are needed, there is no basis on which to introduce variation in costs by project complexity. As in the case of riparian revegetation, the assumption was made that three percent of total costs are attributable to labor and that these costs vary across HSAs according to local wage rates.

Attachment 2 summarizes the estimated aggregate cost of stream bank improvements by HU. These cost estimates are developed using estimates of the amount of stream-side restoration work that will be needed that were provided by the Department. Where the Department provided information only about riparian planting (about two-thirds of SONCC Coho ESU HUs), the assumption was made that about one-half the number of stream miles would need stream bank improvement work as well. [26] In addition, where the Department has provided this information at the HU level, the assumption was made that needs are divided equally among HSAs within an HU.

#### F.4.1.3 Fencing

A common recovery recommendation that is suggested to limit the access of livestock to streams and creeks is fencing. Livestock use of natural water channels stresses stream banks and can cause erosion. Associated sediment can harm salmon. Fencing is often an element of larger riparian revegetation projects, but unit costs of this activity in isolation are also available.

The unit cost of fencing depends on the type of fencing used. More elaborate fencing, with many gates or posts is more expensive to install than simple barbed wire fences. Fencing on steep slopes where significant clearing is required will also be more expensive than projects implemented on flatter ground or with minimal pre-existing vegetation. Evergreen Funding Consultants (2003) suggest budgeting between $3 and $12 per lineal foot for fencing projects. Table F-11 summarizes the average unit cost of various elements of fencing installation projects as calculated by USDA.

To calculate the aggregate cost of fencing activities in the coho salmon ESUs, an average cost of $8 per lineal foot was assumed. Costs are also assumed to vary across HSAs according to the local average construction wages. [27]

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[26] The Department provided estimates of the quantity of riparian revegetation and stream bank improvements needed that was not disaggregated by distance of streams from roads. Thus, while the spreadsheet model allows the analyst to vary the percentage of stream miles treated by distance from the road, in practice we calculate the aggregate cost of this class of recovery action as though all treated stream miles are less than 0.25 miles from roads. This assumption was made because in practice 60 percent of stream miles in the coho salmon range are within 0.25 miles of a road and over 90 percent are within one mile.

[27] Ideally, costs would also vary according to the sort of materials that would be used, with the simplest fencing projects costing about $3 per lineal foot and the most complex projects costing about $12 per lineal foot.

Table F-11: Construction unit cost of fencing project elements in California

| Element of fencing project | Units | Unit cost ($) |
|---|---|---|
| Fence - Gate - 12ft | Each | 75 |
| Fence - Gate - 14ft | Each | 85 |
| Fence - Gate - 16ft | Each | 100 |
| Fence "T" posts | Each | 1.5 |
| Fence Posts (metal) | Each | 8 |
| Fence Posts (wood) | Each | 5 |
| Fencing, Conventional | LF | 3.5 |
| Fencing, Suspension | LF | 2 |
| Fencing, Electrical | LF | 1.5 |
| Fencing (smooth) without power | LF | 1.5 |
| Fencing (woven) 4 inch squares | LF | 3 |
| Fencing (woven) 5 inch squares | LF | 3.25 |
| Cattle Guard (Large) | Each | 4,000 |
| Cattle Guard (Small) | Each | 3,000 |
| Concrete, In Place | CY | 350 |

Source: USDA EQIP Program (2002)
http://waterhome.brc.tamus.edu/NRCSdata/Costs/
Units: LF: linear foot, CY: cubic yard, SF: square foot, AC: acre.

Attachment 2 summarizes the estimated aggregate cost of fencing by HU. These cost estimates are developed using estimates of the amount of fencing that will be needed that were provided by the Department. Where the Department has provided this information at the HU level, the assumption was made that needs are divided among HSAs within an HU equally.[28]

## F.4.2 Socioeconomic Impacts

### F.4.2.1 Riparian revegetation and stream bank improvements

As discussed in section F.4.1.1, information from historical riparian revegetation projects and stream bank restoration projects provides a basis for estimating the fraction of project costs that are attributable to permitting, planning, and mobilization. The socioeconomic impact in the form of regional transfers that will occur as a result of riparian revegetation and stream bank restoration is calculated to be total fiscal costs less that fraction. Estimated socioeconomic impacts by HU as a result of these transfers are summarized in Attachment 2.

Other welfare impacts associated with this class of recovery recommendations are more difficult to quantify because of the limited information available about projects that will actually be

However, at this time we have no basis on which to make inferences about the sort of material that would be used in different HSAs. In the spreadsheet model, this is an option for future analysis.

[28] The Department has provided specific fencing costs for the Davenport HSA in Big Basin, which are incorporated into the analysis.

undertaken as a result of implementation of the Recovery Strategy. These impacts can only be discussed qualitatively at this time.

The full social costs of riparian revegetation and stream bank restoration depend on how the riparian land affected will be treated. If the Department or another entity purchases riparian land for salmon restoration, this land will no longer generate income for its previous owner. The land price that will be paid reflects this foregone income if land markets are competitive. Table F-12 shows illustrative unit values for forest land, which might be purchased for habitat conservation, particularly in riparian areas. These unit values suggest that the social cost of forest land acquisition may be lower in the SONCC Coho ESU than in the CCC Coho ESU, though costs range widely within all counties for which data are available.

Table F-12: Illustrative unit values of the social cost of forest land acquisition, selected California counties ($/acre)

| | Unit prices of forest land | | |
|---|---|---|---|
| County | Average ($/acre) | Minimum ($/acre) | Maximum ($/acre) |
| Sonoma | 3,128 | 1,089 | 5,392 |
| Santa Cruz | 7,347 | 3,167 | 11,063 |
| San Mateo | 7,360 | 1,656 | 15,857 |
| Mendocino | 12,406 | 3,000 | 24,750 |
| Humboldt | 7,181 | 625 | 56,471 |
| Del Norte | 5,914 | 2,417 | 16,204 |

Source: Save the Redwoods League (personal communication, 2003). Prices reflect current dollar actual payments made 1990-2002 for properties larger than ten acres.

If land is not purchased outright for salmon habitat conservation, the Department or other entities may elect to purchase conservation easements on riparian land. Conservation easements pay landowners to restrict development. The per-acre cost of easements is generally lower than the full market price of land; the easement price should reflect the difference between the amount of income that could be earned on a parcel without development restrictions, and the income that can be earned once the easement is in place. For narrow riparian buffers, little income may be available in light of the listing of coho salmon as a threatened or endangered species, but for larger parcels this would not necessarily be the case. The unit price of easements for coho salmon depends on (1) the extent to which listing of coho salmon reduces development options in riparian areas, (2) the area where easements would be sought, and (3) which development rights would be sold.

The cost of conservation easements can vary widely across locations and depends heavily on the precise terms of the easement. Without further information on the terms at which easements would be sought, and where they would be desirable, the impacts of this class of potential recovery actions cannot be estimated at this time. Illustrative values for easement costs have been provided by California Cattleman's Association for the case of rangeland. Easement costs for rangeland in the North Coast can be expected to cost in the range of $400 to $600 per acre. Pacific Forest Trust has provided information about the cost of forest easements in the coho salmon range. They suggest a rule of thumb that easement costs should be about 40 percent of market value given development restrictions that would likely address coho salmon recovery needs. Lower values will be appropriate in more remote regions where development pressures are lower.

Currently, the Department has identified the cost of two recommendations that propose conservation easements (ER-FE-02 and ER-SF-02). The Department estimates that the cost of these recommendations will be $60 million over 10 years, or a present value cost of $51 million, assuming a discount rate of three percent. This amount is included in the estimate of total cost of Recovery Strategy implementation, though additional funds may be required for easements.

In the event that forest land is purchased outright in riparian areas for salmon restoration, or riparian conservation easements are purchased, there may be several associated tax implications. One of these is highlighted, the implications of the title transfer for the property tax paid to the state government on this land. Currently, for the purposes of taxation, timberland in the Redwood Region is assessed according to the schedule presented in Table F-13. According to the California State Board of Equalization, in the event that a timberland parcel is designated as inoperable, as it may well be if purchased for salmon habitat restoration or use is restricted as a result of an easement, it will be valued as if it is Site V (the lowest level of potential forestry productivity). If the parcel was previously assessed at a higher value, the property tax associated with the land may fall, with associated implications for public budgets.



Table F-13: Timberland value assessment for tax purposes in California, 2002

| Site class | Assessed value ($/acre) |
|---|---|
| Site I | 279 |
| Site II | 227 |
| Site III | 198 |
| Site IV | 172 |
| Site V | 54 |

Source: State of California Board of Equalization, November 2002). Site class is classification of the potential productivity of forest land.

### F.4.2.2 Fencing

As discussed in section F.4.1.3, review of average fencing project costs provides a basis for estimating the fraction of project costs that are attributable to permitting, planning, and mobilization. The socioeconomic impact in the form of regional transfers that will occur as a result of fencing is calculated to be total fiscal costs less that fraction. Estimated socioeconomic impacts by HU as a result of these transfers are summarized in Attachment 2.

Other welfare impacts associated with this class of recovery recommendations are more difficult to quantify because of the limited information available about projects that will actually be undertaken as a result of implementation of the Recovery Strategy. These impacts can only be discussed qualitatively at this time.

If fencing projects deprive landowners of a place to water their animals, the cost of tanks and/ or troughs may be included as an element of the full cost of fencing projects. Tanks for livestock watering cost about $2 per gallon, and troughs cost about $1 per gallon (USDA 2002). Labor will also be required to service these tanks that may be greater than the labor requirements associated with watering animals prior to the installation of the fence. Whether the cost of water to service these tanks is a social cost of these projects depends on pre-existing water rights allocations and landowners' obligations as a result of the listing of the coho salmon as endangered or threatened.

## F.5 PLACEMENT OF LWD/ INSTREAM COMPLEXITY

### F.5.1 FISCAL COSTS

Riparian revegetation is intended to create a stock of biomass that will fall into streams and rivers over time, creating pools and other essential salmon habitat. Other projects can be undertaken to speed up the process of generating instream complexity. Large woody debris (LWD) can be placed in waterways, and other activities can be undertaken to improve in-channel habitat. Evergreen Funding Consultants (2003) estimate that LWD placement costs about $20,000 per stream mile; costs rise as the width of water bodies increase and as the size of the material to be placed in channels grows. Engineered log jams can cost as much as $80,000 per structure. Engineered log jams also require significant design and logistic preparation; for example, a series of engineered log jams created on the North Fork Stillagumish River in Washington cost $550,000 to implement and three years of preparation.

Other activities to improve in-channel habitat can be undertaken as part of LWD projects. The average unit cost of these activities in California, as estimated by USDA, is presented in Table F-14. Many of these activities are closely related to erosion control measures and fencing activities discussed previously.

Project costs for in-channel restoration have been developed by the Office of Spill Prevention and Response (OSPR) at the Department. Based on cost estimates reported by Bair (2000)[29]

[29] Bair, B. (2000), Stream restoration cost estimates. In S. Allen, R. Carlson, and C. Thompson (eds.), Proceedings of the salmon habitat restoration cost workshop. Pacific States Marine Fisheries Commission. Gladsone, OR.

and Hampton (2000)[30], OSPR allocates about $60,000 per stream mile for restoration in a small rocky stream and $140,000 per stream mile in a large rocky stream. These cost estimates each include five years of monitoring and maintenance and a ten percent administration fee.

Table F-14: Construction unit cost of in-channel habitat improvement elements in California

| Activity | Units | Unit cost ($) |
|---|---|---|
| Clearing and Snagging | LF | 25 |
| Compacted Fill | CY | 2.5 |
| Critical Area Planting | AC | 1,000 |
| Cut and filling | CY | 130 |
| Fence | LF | 4 |
| Geotextile Fabric | SF | 1.25 |
| Grading and Shaping | AC | 200 |
| Rock/fill | CY | 50 |
| Stream Tree Revetment | Each | 22 |
| Water Control Structure | Each | 15,000 |

Source: USDA EQIP Program (2002)
http://waterhome.brc.tamus.edu/NRCSdata/Costs/
Units: LF: linear foot, CY: cubic yard, SF: square foot, AC: acre.



To estimate the aggregate cost of LWD placement and in-channel restoration in the coho salmon ESUs, the estimates developed by Evergreen Funding Consultants (2003) for LWD placement and the estimates developed by OSPR for in-channel restoration were used. While no systematic information is available about the width of the streams included in the the Department's stream inventory by HU or HSA, information is available about the distance of streams from roads. Evidence presented by Evergreen Funding Consultants suggests that project costs rise as the restoration site becomes more remote from roads. Consistent with this experience in Washington State, the assumption was made that project costs rise as the distance of streams from roads increases. The assumption was also made that costs will vary among HSAs on the basis of construction industry wages. Thus, projects in remote areas in high wage regions will be relatively more expensive per stream mile than identical projects, in terms of materials used, in low-wage areas at easily accessible sites.

For general in-channel restoration activities, following OSPR the assumption was made that permitting costs are about $15,000 per stream mile, regardless of project location. All other costs total $25,000 per stream mile for project sites within 0.25 miles from a road. OSPR reports that labor costs generally total about eight percent of non-permitting costs. This information was

30 Hampton, S. (2000), The costs of restoring anadromous fish habitat: Results of a survey from California. In S. Allen, R. Carlson, and C. Thompson (eds.), Proceedings of the salmon habitat restoration cost workshop. Pacific States Marine Fisheries Commission. Gladsone, OR.

used to estimate how project costs vary among HSAs according to the relative costliness of labor. As in the case of LWD projects, the assumption was made that non-permitting costs rise as streams become more distant from roads. In particular:

- Sites between 0.25 and 0.5 miles from a road have non-permitting project costs of $26,000 per mile;
- Sites between 1 and 2 miles from a site have non-permitting project costs of $27,000 per mile;
- Sites that are between 2 and 3 miles from a road have non-permitting project costs of $28,000 per mile; and
- Sites further than 3 miles from a road have non-permitting project costs of $29,000 per mile.

For LWD placement alone, the assumption was made that for sites less than 0.25 miles from a road, project costs will be $20,000 per mile on average. The assumption was made that permitting costs account for about 38 percent of total costs and labor accounts for about eight percent of non-permitting costs, consistent with the assumptions made about instream complexity work. As sites increase in distance from roads, total unit costs rise in the following manner:

- Sites between 0.25 and 0.5 miles from a road have project costs of $21,000 per mile,
- Sites between 1 and 2 miles from a site have per mile project costs of $23,000,
- Sites that are between 2 and 3 miles from a road have per mile project costs of $25,000, and
- Sites further than 3 miles from a road have project unit costs of $30,000.

Attachment 3 summarizes the estimated aggregate cost of LWD placement and restoring in-channel complexity by HU. These cost estimates were developed using estimates, provided by the Department, of the amount of LWD placement and in-channel restoration work that will be needed, and, in the case of the CCC Coho ESU, total cost estimates by HSA. Where the Department provided information only about LWD needs (about two-thirds of HUs in the SONCC Coho ESU), the assumption was made that a similar number of stream miles would need in-channel restoration work as well. [31]

### F.5.2 SOCIOECONOMIC IMPACTS

As discussed in section F.5.1, review of historical LWD placement projects and instream restoration projects provides a basis for estimating the fraction of project costs that are

[31] The Department provided estimates of the quantity of in-stream restoration needed that was not disaggregated by distance of streams from roads. Thus, while the spreadsheet model allows the analyst to vary the percentage of stream miles treated by distance from the road, in practice we calculate the aggregate cost of this class of recovery action as though all treated stream miles are less than 0.25 miles from roads. This assumption was made because in practice 60 percent of stream miles in the coho salmon range are within 0.25 miles of a road and over 90 percent are within one mile.

attributable to permitting, planning, and mobilization. The socioeconomic impact in the form of regional transfers that will occur as a result of LWD placement and instream restoration was calculated to be total fiscal costs less that fraction. Estimated socioeconomic impacts by HU as a result of these transfers are summarized in Attachment 3.

## F.6 ROAD TREATMENT AND DECOMMISSIONING

The Recovery Strategy contains several broad categories of recommendations dealing with roads, which differ in their unit cost, socioeconomic impacts and, likely, in their cost-effectiveness. The broad categories of recommendations are:

1. Road decommissioning;
2. Road upgrading;
3. Relocation of roads in riparian areas;
4. Implementation of best-management practices (BMPs) in road construction; and
5. Limiting use of roads (e.g., in winter or if road is legally closed).

Many road treatment actions are recommended in conjunction with culvert replacement (see the discussion of barriers to fish passage above). For most HSAs where roads are identified as a source of sediment that harm coho salmon, the CRT also urges road and sediment assessments.[32] To the economists' knowledge, little quantitative information about the number of road miles needing each of the recommended actions is available at this time, so it is impossible to calculate precisely the cost of this class of recovery recommendations.[33] This section includes a discussion of the unit cost of road decommissioning and road upgrades (many BMPs in road construction are also implemented in road treatment after initial construction). It also includes a discussion of the socioeconomic cost of limiting the use of certain roads to reduce erosion that is harmful to coho salmon.

### F.6.1 FISCAL COST

#### F.6.1.1 Road treatment

A variety of activities can be undertaken to reduce the sediment burden associated with previously constructed roads. Pacific Watershed Associates (2003) summarizes these as "stormproofing" activities, which remove unstable sidecast and fill materials from steep slopes



32 There are other recommendations that are more general exhortations to control legacy sediment sources, or to avoid the creation of new sediment sources. We assume that these are related to either road upgrading or the adoption of BMP in road construction.

33 This is not surprising. Anywhere from 15 to 50 percent of roads on the landscape are not on maps maintained by large timer companies, counties and the state (Weaver, B., (2002), Road upgrading, decommissioning, and maintenance- estimating costs on small and large scales. In S. Allen, R. Carlson, and C. Thompson (eds.), Proceedings of the salmon habitat restoration cost workshop. Pacific States Marine Fisheries Commission. Gladsone, OR.)

and in other appropriate locations, and also apply surface drainage techniques.[34] Stormproofing can also include upgrading stream crossings.

Illustrative unit costs for typical road treatment activities in California as calculated by USDA are summarized in Table F-15. Along a given stretch of road, the number of rolling dips and water crossings that will be required to adequately treat sediment is project-specific. It depends on both the soil type and the grade of the road. Treating steeper roads with more erosive soils will require more rolling dips and waterbars per mile (Keller and Sherar 2003).[35]

Actual road treatment projects in California and the Northwest suggest that this recovery action can cost as much as $46,000 per mile. Based on approximately 325 miles of roads of various types, Weaver (2002) estimates that watershed-wide road-upgrading costs fall between $10,000 and $35,000 per mile. To illustrate the categories of costs that are incurred, Table F-16 summarizes unit and project costs for treating road-related erosion in San Mateo County. Pacific Watershed Associates (2003b) finds that treating 6.5 miles of road in this county will cost about $117,000.[36]

Table F-15: Construction unit costs for road treatment activities in California

| Activity | Units | Unit cost ($) |
|---|---|---|
| Compacted Fill | CY | 2.5 |
| Earthwork excavation | CY | 1.5 |
| Grading and Shaping | AC | 200 |
| Grading Shaping and Filling | AC | 500 |
| Road & Landing Removal | AC | 2000 |
| Rolling Dip | Each | 350 |
| Rock Ford or Crossing | Each | 4,000 |
| Waterbar | Each | 150 |

Source: USDA EQIP Program (2002)
http://waterhome.brc.tamus.edu/NRCSdata/Costs/

Units: LF: linear foot, CY: cubic yard, SF: square foot, AC: acre.

The survey results reported by Weaver (2002) and the figures in Table F-16 are the basis for the unit cost estimates used to estimate the aggregate cost of road treatment in the coho salmon ESUs. The assumption was made that labor costs account for about 40 percent of total costs and that the labor element of the unit cost of road treatment varies across HSAs according

34 Pacific Watershed Associates (2003), Watershed assessment and erosion prevention planning project for the Garrapata Creek Watershed, Monterey, CA. Prepared for Department of Fish and Game, March 2003.

35 Keller G. and J.Sherar (2003), Low-volume roads engineering: Best management practices field guide. US Agency for International Development and USDA, Forest Service. Available: http://www.zietlow.com/manual/gk1/forewrod.pdf.

36 Pacific Watershed Associates (2003), Sediment assessment of roads and trails within the Pescadero/Memorial/Sam McDonald County Part Complex. Report prepared for San Mateo County Parks and Recreation Department and California Department of Fish and Game, February, 2003.

to local wage rates. Since San Mateo County is a relatively high-wage region, (construction wages in this county were 126 percent of the California average in 2002), the assumption was made that the state-wide average labor cost per mile is $5,900 (74 percent of $8,000 which is the per mile cost of labor in Table F-16). The assumption was made that the state-wide average cost of the non-labor component of road treatment is $10,000 per mile (the per mile non-labor treatment cost in Table F-16). This cost is assumed to be constant across HSAs. Planning, mobilization and permitting are estimated to be about 25 percent of total project costs per mile (as they are in the example presented above). The average total per-mile cost is $15,900.

Table F-16: Illustrative unit and project costs for road-related erosion control (San Mateo County, CA)

| Cost element | | Unit cost ($/hr) | Time commitment (hours) Treatment | Logistics | Total | Total costs ($) |
|---|---|---|---|---|---|---|
| Moving expenses | Excavator | 110 | 3 | 0 | 3 | 330 |
| | Dozer | 85 | 3 | 0 | 3 | 255 |
| Equipment for site treatment | Excavator | 135 | 18 | 5 | 23 | 3,105 |
| | Dozer | 95 | 47 | 14 | 61 | 5,795 |
| Equipment for drainage sites | Bobcat | 95 | 124 | 37 | 161 | 15,295 |
| | Dozer | 95 | 3 | 1 | 4 | 380 |
| | Bobcat | 95 | 27 | 8 | 35 | 3,325 |
| Laborers | | 35 | 1,142 | 343 | 1485 | 51,975 |
| Foot bridges | | | | | | 6,000 |
| Culvert materials | | | | | | 155 |
| Rocks | | | | | | 1,320 |
| Mulch etc. | | | | | | 275 |
| Planning etc. | | | | | | 29,100 |
| Total | | | | | | 117,310 |

Source: Pacific Watershed Associates (2003b).
Total project covers 6.5 miles of road; unit cost is $18,000 per mile.

The Department has provided information about the approximate number of road miles that will need treatment or decommissioning in the Cape Mendecino, Eel River, Eureka Plain, Klamath River, Mad River, Redwood Creek, Rogue River, Smith River, Trinidad, Trinity River, and Winchuck River HUs. The assumption was made that the distribution of these road miles among the HSAs in these HUs is approximately equal to the distribution of U.S. Geological Survey (USGS) Class 4 (unpaved or unimproved) roads in rural forest regions. The Department has provided information about the approximate number of road miles that will need treatment or decommissioning in each of the HSAs in the Mendocino Coast, Marin, San Mateo, Russian River, Bodega and Big Basin HUs.

The assumption was made that 85 percent of roads identified by the Department as needing treatment will require stormproofing. This is consistent with a survey of typical findings on a watershed-by-watershed basis reported by Pacific Watershed Associates (2003).[37] The estimated cost of road treatment by HU is summarized in Attachment 4.

The Recovery Strategy proposes the adoption of best management practices in new road construction. This may entail increased costs for both the public and private sectors. For example, this may require constructing more rolling dips when new roads are created than might otherwise have been the case. However, these increased up-front costs may be off-set to some degree be reduced ongoing maintenance costs. Because information is not currently available on the amount of roads that will be built over the next 25 years by HSA, the cost of these road-related recovery actions cannot be quantified at this time.

#### F.6.1.2 Road decommissioning

Modern road decommissioning is a form of reverse road construction that is generally appropriate for only a portion of a road inventory slated for sediment reduction treatment. On average, about 10 to 20 percent of a problem road network will require decommissioning (Pacific Watershed Associates 2003).

Table F-17 summarizes estimates of the unit costs of typical road decommissioning activities gathered by the Environmental Protection Agency. Similar costs for ripping and decompaction are reported by Weaver (2002). While these numbers are instructive, a review of actual road decommissioning projects undertaken by Harr and Nichols (1993) suggests that decommissioning costs per mile depend crucially on whether waterbars must be constructed, and the extent of tree removal that must be undertaken prior to excavation. Harr and Nichols's widely-cited findings are summarized in Table F-18. In current dollars, the results of their survey suggest that road decommissioning costs can vary from about $3,400 per mile to about $9,000 per mile. Labor requirements per mile also vary widely depending on the difficulty of the tree removal task.

Coffin (2000)[38] reviewed the cost of road decommissioning in the Gifford-Pinchot National Forest. He found that costs range from about $3,000 per mile to $23,000 per mile and average about $10,000 per mile. Mobilization costs, including permitting are more stable, about $4,000 per project regardless of project size. As Coffin emphasizes, since mobilization costs include permitting, these costs depend on who owns the land where the road to be decommissioned is found. Environmental permitting may be less expensive on non-federal lands.

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[37] In practice, the percentage of roads that will be treated will depend on the threshold level of sediment delivery that is used to define sites as treatment-worthy. This threshold can vary from 20 to 50 cubic yards (Weaver 2002). No guidance is given by the Recovery Strategy as to what the threshold will be for the purposes of coho salmon recovery.

[38] Coffin, B., (2000), Estimating costs of road decommissions, In S. Allen, R. Carlson, and C. Thompson (eds.), Proceedings of the salmon habitat restoration cost workshop. Pacific States Marine Fisheries Commission. Gladsone, OR.

Table F-17: Illustrative unit costs for road decommissioning activities

| Treatment method | Cost ($/mile) |
|---|---|
| Ripping/ scarification | |
| Ripping with D7 or D8 tractor | 700 |
| Scarification with D8-mounted brush blade | 1,100 |
| Scarification to 6-inch depth and installation of water bars with track hoe | 2,100 |
| Ripping and slash scattering with track hoe | 600-800 |
| Ripping, slash scattering, and water bar installation with track hoe | 1,000 |
| Ripping with track hoe | 300-500 |

Source: EPA Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (available: www.p2pays.org/ref/04/03686/index-3.html). Cost estimates converted to 2000 dollars using price index developed by Summers and Heston (2003) and rounded to nearest 100 dollars.

Table F-18: Illustrative project costs for road decommissioning

| Project number | Description of road treatment required | Length of segment (mile) | Time required (hours) | Cost ($) | Cost ($)/mile |
|---|---|---|---|---|---|
| 1 | Minimal removal of small trees, pre-existing water-bars | 7 | 232 | 23,700 | 3,400 |
| 2 | Extensive clearing of large trees | 1.6 | 135 | 14,000 | 8,800 |
| 3 | Extensive clearing, pulling sidecase, constructing sidebars | 0.8 | 77 | 7,300 | 9,200 |

Source: Harr and Nichols (1993). Authors' conversion to 2000 dollars using price index developed by Summers and Heston (2003) and rounded to nearest 100 dollars.
Decommissioning of 11 road segments in Canyon Creek, Washington in 1987-88.
Case (3) is an average of four different projects.

To calculate the cost of road decommissioning, the assumption was made that the per-mile cost will be consistent with the findings of both Harr and Nichols (1993) and Coffin (2000). The assumptions were made that the unit cost of road decommissioning is $9,000 per mile and that labor costs represent about 40 percent of total costs, just as they do in the road treatment aggregate cost calculation. Mobilization/ permitting costs total about $3,000 (slightly lower than the mobilization cost estimates provided by Coffin because most roads in the California range of coho salmon are on non-federal land). Non-permitting costs are assumed to vary by HSA according to local construction wages. Mobilization/ permitting costs are assumed to be constant across HSAs.

The Department has provided information about the approximate amount of road miles that will need treatment or decommissioning in the Cape Mendecino, Eel River, Eureka Plain, Klamath River, Mad River, Redwood Creek, Rogue River, Smith River, Trinidad, Trinity River, and

Winchuck River HUs. In these HUs, the assumption was made that 15 percent of these road miles will ultimately require decommissioning. The assumption was made that the distribution of these road miles among the HSAs in these HUs is approximately equal to the distribution of USGS Class 4 (unpaved or unimproved) roads in rural forest regions. For other HUs, road miles requiring treatment were provided at the HSA level. The estimated of the cost of road treatment by HU is summarized in Attachment 4.

### F.6.2 Socioeconomic impacts

As discussed in section F.6.1, review of historical road treatment and decommissioning projects makes it possible to estimate the fraction of project costs that are attributable to permitting, planning, and mobilization. The socioeconomic impact in the form of regional transfers that will occur as a result of road treatment and decommissioning has been calculated to be total fiscal costs less that fraction. Estimated socioeconomic impacts by HU as a result of these transfers are summarized in Attachment 4.

Other welfare impacts associated with this class of recovery recommendations are more difficult to quantify because of the limited information available about projects that will actually be undertaken as a result of implementation of the Recovery Strategy. These impacts can only be discussed qualitatively at this time.

Limiting the use of certain roads in the winter or relocating roads imposes economic costs and more time and fuel must be spent to reach desired destinations. Given the limited data available on roads in general, and the lack of identification of which roads would in practice have access limited, it is impossible to quantify the cost of this road-related recovery recommendation.

## F.7 RESTORING WETLANDS AND OFF-CHANNEL AREAS

### F.7.1 Fiscal costs

In a limited number of HUs/HSAs wetlands restoration is mentioned as a recommended recovery activity. The unit costs of common wetlands restoration activities, as calculated by USDA for California, are summarized in Table F-19. As this table suggests, many of the activities that fall under the category of wetlands restoration are also common to the other categories of restoration activities considered in this document. For example, USDA considers culvert replacement, fencing, and critical area planting to be activities that may be undertaken as part of wetlands restoration. Because the quantities of these activities that will be undertaken in any given HSA are not generally known, the aggregate cost of wetlands restoration has not been calculated as an activity that is distinct from other, related recovery recommendations.

### F.7.2 Socioeconomic impacts

The analysis of the socioeconomic impacts of wetlands restoration is similar to that for riparian revegetation and conservation easements.

Table F-19: Construction unit costs for wetlands restoration activities in California

| Activity | Units | Unit cost ($) |
|---|---|---|
| Arch culverts | Diameter-LF/LF | 32.8 |
| Concrete, Non-Structural Non-Reinforced | CY | 150 |
| Concrete, Non-Structural Reinforced | CY | 250 |
| Critical Area Planting | AC | 1000 |
| Deleveling | AC | 300 |
| Earthwork excavation normal | CY | 1.5 |
| Fence | LF | 4 |
| Mobilization | Each | 1250 |
| Riparian Herbaceous Cover | AC | 500 |

Source: USDA EQIP Program (2002) http://waterhome.brc.tamus.edu/NRCSdata/Costs/
Units: LF: linear foot, CY: cubic yard, SF: square foot, AC: acre.

## F.8 WATER ACQUISITIONS

Water markets are an increasingly important means of allocating scarce water supplies in California. Additionally, they have become a prime tool used by government agencies to enhance instream flows. Hanak (2003) shows that environmental water purchases by the state and federal governments now account for the largest and fastest-growing share of water transfers in California.

Environmental water transfers can take a variety of forms. The most common is an intrayear or "spot" transaction where the landowner sells all or a fraction of his entitlement to the agency. The transaction is for one year only and there is no change underlying water rights. Typically, farmers fallow their land under such an arrangement to reduce consumptive use, but other arrangements are possible (such as a shift to groundwater pumping) when environmental conditions allow. Other potential arrangements include long-term or permanent transfers involving a reduction in the agricultural base, and intermittent or "options" transfers where there is a long-term contract between the landowners and the agency but the water is transferred only under certain conditions.

The price at which water is sold on environmental water markets is determined by negotiations between landowners and the purchasing entity. Because the transfer is voluntary, the lowest price at which a farmer will sell is called the "reservation price" and is equal to the net operating income (or revenue minus variable costs) earned per unit sold. As a rough rule of thumb, the methods used by BOR and the California Department of Water Resources were followed and the assumption was made that the market price of water is 50 percent greater than the reservation price.

The Recovery Strategy includes the recommendation of land acquisition and/or water rights acquisition in several HSAs. In practice, water rights acquisition functions very similar to land acquisition. In agricultural areas where farmed land is irrigated, loss of water rights generally means in practice that land formerly irrigated with this water will be left fallow. The seller of water rights forgoes the agricultural profits that would have been gained in the event that the water had been used for irrigation. However, as previously noted, other arrangements are possible (such as a shift to groundwater pumping) when environmental conditions allow.

### F.8.1 FISCAL COST

In circumstances where potential sellers of water rights do not shift to groundwater pumping or make other arrangements such that agricultural lands are not left fallow, potential sellers of water rights may forgo the agricultural profits they would have gained from irrigating. In these circumstances, the annual cost of an acre-foot of water in a particular HSA can be predicted to be equal to the net agricultural returns (gross returns less operating costs) that water would have created.

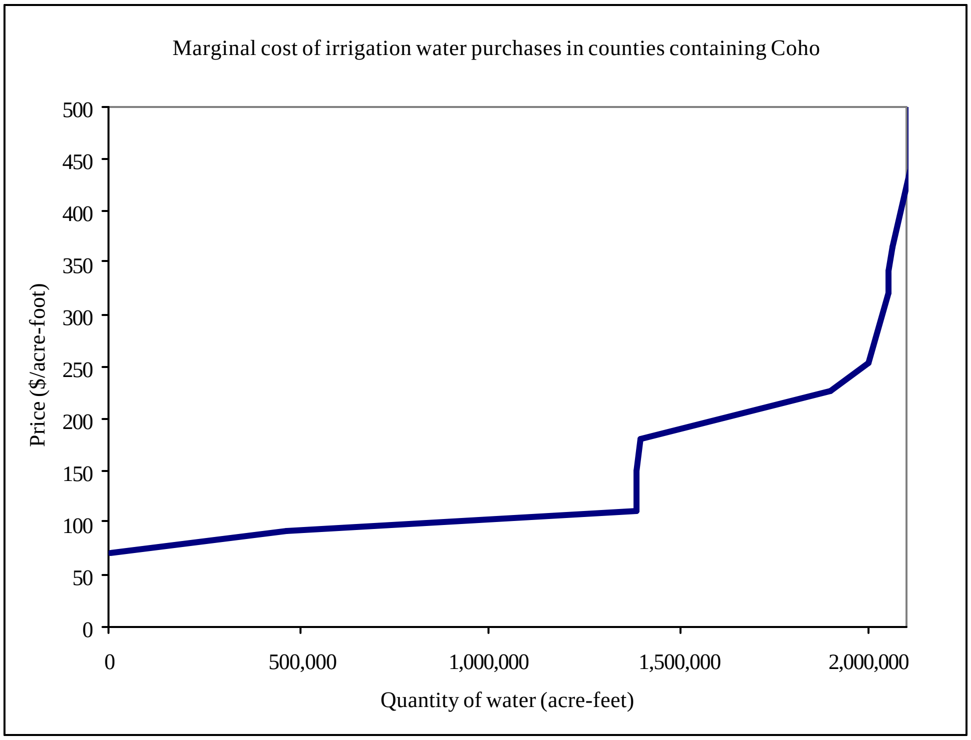
By combining data on acre-feet of irrigation water per acre used in a particular HSA with information about net agricultural returns per acre, the price of an acre-foot of water can be estimated. Agricultural census data on irrigated pasture and crop land by county and county-level data on irrigated water withdrawals for pasture and crops provided by USGS were used to calculate acre-feet of water per acre of pasture and crops planted by county. Farm operating costs and gross agricultural returns per acre for pasture and typical crops were provided by U.C. Extension's current cost and return studies. The calculation takes the form:

$$(G_{it} / acre_{it} - C_{it} / acre_{it}) * acre_{it} / W_{it} = P_{it} / W_{it} \qquad (1)$$

where, for crop *i* (*i* = pasture, crops) in county *t*, *G* is gross agricultural returns, *C* is agricultural operating costs, *W* is acre-feet of water used, and *P* is the price of water, measured in dollars. The variable *acre* measures acres planted in crop *i* in county *t*. The equation is solved for $P_{it} / W_{it}$, which is the minimum payment that would be made for water acquisitions. The actual values of these parameters are presented in Attachment 5. As discussed above, the assumption was made that prices paid for water acquisitions in practice will be 1.5* $P_{it} / W_{it}$.

The aggregate fiscal cost of water acquisition and agricultural land acquisition will depend on the quantity of water and/or land to be acquired and whether water rights will be permanently transferred or purchased for single periods. The marginal cost of annual water rights acquisition is summarized in Figure F-1. The curve is non-linear because costs increase sharply when acquisition of irrigation water for pasture is complete and increasingly high value cropland (e.g., winegrapes, broccoli) is left fallow.

Figure F-1 Marginal cost of annual water rights acquisition




## F.8.2 SOCIOECONOMIC IMPACTS

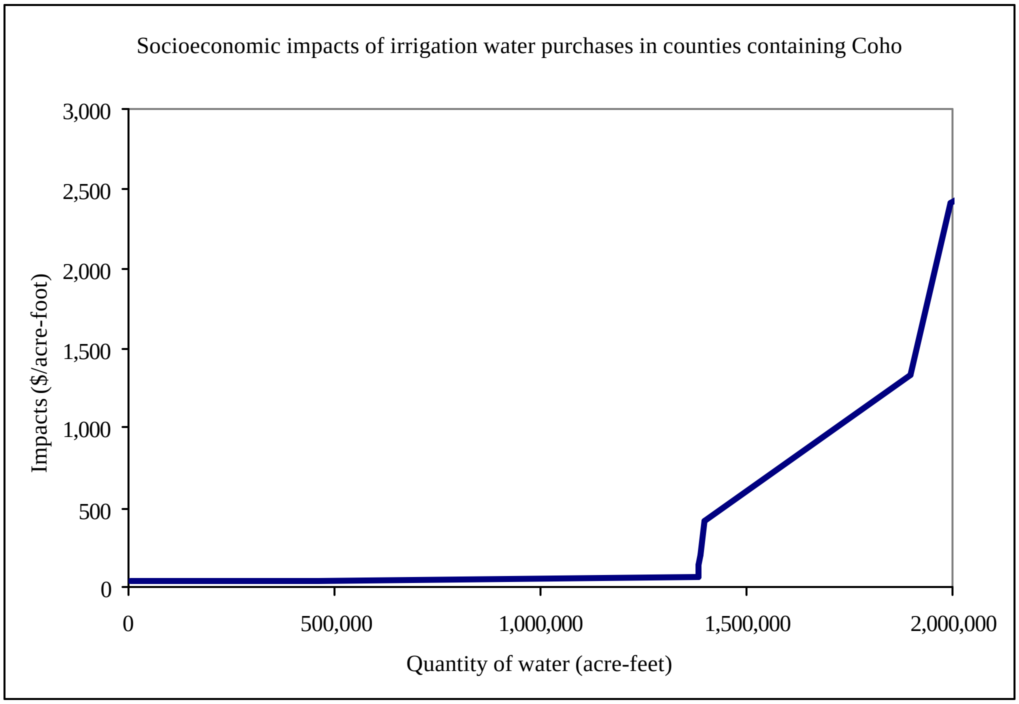
Taking agricultural land out of production so that more water is available for coho salmon recovery has a socioeconomic cost because land that once provided private income no longer does so. Conceptually, when agricultural land formerly harvested is left fallow because irrigation water has been transferred to serving the needs of coho salmon, the farmer that sold the water right has neither lost nor gained income. She has received at least the same profit from the sale of water that she would have if the relevant parcel of land had been planted. However, the laborers that worked this land and the firms that sold the farmer inputs for this land have not been made whole. Their lost income, equal to the farmer's operating costs in the event that she had planted and harvested the parcel of land, are the socioeconomic cost of this recovery action.

Assuming that water is acquired at the lowest possible fiscal cost, it is possible to calculate and graph the socioeconomic cost of water rights acquisitions, per acre-foot of water purchased, that is implied by the price schedule shown in Figure F-1. The socioeconomic cost can be calculated with an equation similar to equation 1, which takes the form:

$$(C_{it} / acre_{it}) * acre_{it} / W_{it} = SE_{it} / W_{it} . \qquad (2)$$

All variables are defined as above, except the equation now calculates the socioeconomic cost, *SE*, of water rights acquisitions. This equation was solved for $SE_{it} / W_{it}$. The socioeconomic impacts of water purchases are shown in Figure F-2. Impacts are fairly low until quantity purchased exceeds 1.4 million acre feet.

Figure F-2 Socioeconomic impacts of water rights acquisition




## F.9 BIOLOGICAL STUDIES

### F.9.1 FISCAL COSTS

The Recovery Strategy recommends a range of technical studies from monitoring efforts to genetic analyses. A review of the Department's inventory of restoration activities suggests that individual monitoring projects can be expected to cost about $160,000 on average. Projects that include surveying and other research efforts that the Department has funded or partially funded have cost about $176,000 on average. These historical averages were used to estimate the cost of recovery recommendations that are technical monitoring or biological research activities.

There are about 30 recovery recommendations that recommend biological or technical scientific studies. The cost of recovery recommendations that are biological studies have been estimated to be about $7 million.[39] These costs are not discounted because this class of recovery action is generally assumed to be an interim action, occurring in the near future.

There are about 10 recovery recommendations that are clearly identifiable as monitoring efforts. The annual cost of the cost of the monitoring efforts is estimated to be about $1.4 million on the basis of the historical project costs described above. Assuming that the same amount will be spent each year on each monitoring effort, when these cost estimates are expressed in present value, assuming recovery over 25 years and a discount rate of three percent the estimated total cost of this class of recovery action is about $24 million.[40]

### F.9.2 SOCIOECONOMIC IMPACTS

The socioeconomic impacts of this class of recovery recommendations are not expected to be significant.

## F.10 WATERSHED PLANNING AND OTHER NON-BIOLOGICAL STUDIES

### F.10.1 FISCAL COSTS

As mentioned throughout this section, many recommendations for specific recovery recommendations are accompanied by a recommendation that planning and prioritization efforts precede implementation. Planning recommendations may call for broad watershed planning, or more targeted exercises such as barriers or road inventories.

The Department has supplied a database that summarizes all recovery efforts that it has currently or partially funded for anadromous salmonids in the recent past. This includes approximately 60 planning efforts, for a wide variety of purposes. The average cost of these planning exercises (excluding a major coast-wide effort led by the Department itself and two very small projects that appear to be either mis-characterized or anomalous) is about $186,000. Costs of planning efforts can vary widely; even excluding the outliers mentioned above, the Department's records include efforts that cost as little as $10,000 and those that cost over $1,000,000 in total. As an initial means of estimating the cost of planning activities, the conservative assumption that each planning recovery action will cost about $200,000 was made. There are about 63 recovery recommendations that are non-biological studies or planning exercises. This implies that the total cost of this class of recovery recommendations is estimated to be about $13 million.[41] These costs do not vary systematically across HSAs.



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39 For five of these recommendations, the Department has identified more precise costs estimates. These are BM-WA-05, BM-WA-08, KRHU-8, SHSA-2, and SLHSA-3. These are estimated to cost $500,000, $500,000, $1.5 million, $600,000, and $200,000 respectively. The estimate of the aggregate cost of this class of recovery recommendations reflects these costs.

40 For three of these recommendations, the Department has identified more precise costs estimates. These are KGHSA-18, SRHU-17, and KRHU-18. These are estimated to cost $200,000 $30,000, and $30,000 per year respectively. The estimate of the aggregate cost of this class of recovery recommendations reflects these costs.

41 For four of these recommendations, the Department has identified more precise costs estimates. These are BBHU-6, BBHSA-3, OCHSA-1, and SoqHSA-2. These are estimated to cost $400,000 $250,000, $250,000, and

The assessment of barriers to passage as a cost associated with treating barriers was included in that category, and not a cost that is part of this class of recovery recommendations. Assessing barriers to passage is assumed to cost about $20,000 per HSA.

### F.10.2 SOCIOECONOMIC IMPACTS

The socioeconomic impacts of this class of recovery recommendations are not expected to be significant.

## F.11 EDUCATION AND OUTREACH

### F.11.1 FISCAL COSTS

In many different contexts and HSAs, the Recovery Strategy recommends performing education and outreach (including efforts to increase or improve inter-agency coordination) regarding salmon recovery and habitat restoration. While estimating the cost of any particular education effort would be difficult, it is possible to predict the average unit costs of education and outreach efforts.

The Department has supplied a database that summarizes all recovery efforts that it has currently or partially funded for anadromous salmonids in the recent past. This includes information about 200 education and outreach programs. The average cost of an education or outreach activity is about $67,000 according to this database. Costs are slightly lower, about $49,000 per program, when programs specifically concern coho salmon, as opposed to other anadromous salmonids.

On the basis of this survey, the economists assumed that the annual cost of education and outreach programs regarding coho salmon recovery and habitat restoration will be about $60,000, and, as recommended by the Recovery Strategy, about 61 education programs (including technical assistance efforts) will be undertaken. [42]

Assuming that an equal amount will be spent each year on each education and outreach program, when these cost estimates are expressed in present value, assuming recovery over 25 years and a discount rate of three percent the estimated total cost of this class of recovery action is about $31 million.

### F.11.2 SOCIOECONOMIC IMPACTS

The socioeconomic impacts of this class of recovery recommendations are not expected to be significant.

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$300,000 respectively. The estimate of the aggregate cost of this class of recovery recommendations reflects these costs.

[42] For a limited number of recommendations, the Department has supplied more precise cost estimates. These are recommendations BM-WA-02, BM-LA-11, BM-LA-12B, BHU-2, and ERHU-1 which are estimated to cost $50,000, $50,000, $50,000, $20,000 and $500,000 respectively. Aggregate cost estimates reflect these figures.

## F.12 HSA/HU SPECIFIC RECOMMENDATIONS

In the Recovery Strategy there are about 20 recommendations that address specific concerns in individual HSAs. In consultation with the Department, the economists have identified estimates of the cost of each of these activities.[43] These recommendations and cost estimates are summarized in Table F-20. Where possible, these cost estimates have been included in the estimates of aggregate costs.

Table F-20: HSA/HU-specific[1] recommendations for which costs are implemented individually

| Number | Recommendation | Estimated cost ($) |
|---|---|---|
| KR-HU-20 | Restore appropriate coarse sediment supply and transport near Iron Gate Dam. Means to achieve this could include full or partial removal of the Klamath River Project, or gravel introduction such as is done below other major dams (e.g., Trinity Dam). | 500,000,000 |
| KR-KG-12 | Encourage cooperation between industrial timber land managers and tribes to restore coho salmon habitat Use the successful Tribal/Simpson Resource Company program as an example. | none |
| KR-KG-17 | Continue funding and technical support for the California Conservation Corps to continue their collaborative participation with the Yurok Tribe and Simpson Resource Company to implement watershed restoration throughout the lower Klamath sub-basin. | 1,100,000 per year |
| TR-HU-01 | Implement the Trinity River Record of Decision (ROD). See Chapter 9 in the Recovery Strategy for the full text of the recommendation. | 12,000,000 per year |
| EP-HU-04 | Acknowledge the Arcata City Sewage Treatment Project and encourage implementation of similar projects elsewhere where possible. | none |
| EP-HU-06e | Maintain and protect channel conditions important for all life stages of coho salmon. | 14,180,000 |
| From EP-HU-06e | Restore channel conditions important for all life stages of coho salmon. | Included in costs for EP-HU-06e |
| MC-GA-06 | Utilize as a model for erosion reduction and LWD placement the comprehensive approach practiced in the South Fork of the Garcia River. | none |
| MC-GA-11 | Maintain Hathaway Creek, North Fork Garcia, Rolling Brook, Mill Creek (lower Garcia River), South Fork Garcia, Signal, Mill Creek (upper Garcia River) to continue to provide coldwater input to the mainstem Garcia. | none |
| MC-GA-16 | Excavate a geomorphically designed channel in the lower North Fork Garcia to rectify subsurface flow during summer months and prevent coho salmon stranding. | 25,000 |
| RR-GU-03 | Stock Willow, Sheephouse, Freezeout, Dutchbill and Green | 1,500,000 |

43 There are some recommendations for which costs cannot be assigned. These recommendations (e.g., beaver investigations; water drafting for fire suppression, expressions of encouragement) are too vague to assign costs to at this time.

| Number | Recommendation | Estimated cost ($) |
|---|---|---|
| | Valley creeks as part of the coho salmon broodstock program. | |
| RR-HU-07 | Implement Sotoyome Resource Conservation District's Fish Friendly Farming Program within Sonoma and Mendocino counties. | 60,000 |
| RR-HU-08b | Stock first priority barren streams, including Felta and Mill Creeks (tributary to Dry Creek west of Healdsburg), Freezeout, Willow and Sheephouse Creeks (near Duncan Mills), and Ward Creek (tributary to Austin Creek). Identify additional streams that may be suitable for stocking as restoration occurs; | 1,000,000 |
| RR-HU-13 | Review and, if appropriate, approve the FishNet 4C manual: Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Operations and Maintenance (Draft Dec 2002). | 200,000 per year, per county |
| RR-AC-03 | Stock high-priority barren streams, including Ward Creek, with the coho salmon broodstock program. | 1,500,000 |
| RR-WS-03 | Stock high priority barren streams, such as Mill and Felta Creeks, as part of the coho salmon broodstock program. | 1,500,000 |
| BM-WA-05 | Implement high priority coho salmon enhancement projects for the reduction of sediment delivery and the restoration of riparian corridors as listed in the Walker Creek Enhancement Plan (2001). | 500,000 |
| BM-BO-02 | Continue restoration efforts on Bolinas and Big lagoons to benefit coho salmon during all life phases and seasons. | 7,000,000 |
| BB-HU-01 | Continue to operate MBSTP Kingfisher Flat Hatchery as a conservation hatchery, following the guidelines of the Department and NOAA Fisheries. | 40,000 per year |
| BB-HU-07 | Develop a lagoon management plan that addresses the needs of coho salmon. | 400,000 per county |

Note:
1. The recommendations are listed in the order they appear in Chapter 9 of the Recovery Strategy.
Source: DFG.

## F.13 TIMBERLAND MANAGEMENT

Three alternative sets of recommendations were developed for timberland management in areas with coho salmon. One alternative, Alternative A, was presented to the CRT by petitioner members of that team. The second and third alternatives, Alternative B and Alternative C, were developed by the Department in part (specifically sections 1-10 of these alternatives) from a recommendation that was presented to the CRT by forest landowner representatives of that team.

This section measures the cost to forest landowners or companies from implementing these various alternatives. This is an implicit calculation of fiscal cost to companies of implementing these alternatives. Results are developed and expressed in a manner consistent with the rest of the document. First, each alternative was separated into its components with the most potential to change resource allocation. Next, for each recovery action the per-acre cost of effecting the change was calculated. Then, this per-acre cost was multiplied by the number of acres affected by the Recovery Strategy to obtain the total cost. At this stage, there are insufficient data to calculate socioeconomic costs of implementing these alternatives.

While there are at present three alternatives, we calculate costs for Alternatives A and B. There are few incremental costs associated with Alternative C. The total cost of implementation depends on what is included in the Recovery Strategy for timber management.

### F.13.1 ALTERNATIVE RECOMMENDATIONS

Discussions of Alternatives A, B, and C are provided in this section.

#### F.13.1.1. ALTERNATIVE A

Alternative A could be implemented in two different ways. The Commission could approve this alternative for inclusion in the strategy as: (1) guidelines (pursuant to FGC §2112) for issuance of Incidental Take Permits under FGC §2081(b) or consistency determinations under FGC §2080.1 where these recommended measures would fully mitigate take and at the same time contribute to the recovery of coho salmon. The effect of this would be to streamline the permitting process as an incentive for recovery. In accordance with FGC §2114, the guidelines would be part of the Commission's rulemaking for listing; or (2) a recommendation to the California Board of Forestry and Fire Protection (BOF) to implement it through a rulemaking proceeding to establish regulations that ensure that timber operations are consistent with the long-term survival of coho salmon.

The most expensive component of Alternative A is the restriction on timber companies to operate on unpaved roads in the wet season. In particular, "use of any unpaved road segments within or appurtenant to a timber harvest plan area shall cease when any of the following occur: (a) precipitation is sufficient to generate overland flow off the road surface; or (b) use of any portion of the road results in rutting of the road surface. Road use shall not resume until the rod is dry. "Dry" is defined as a road surface that is well drained; and is not rutting, discharging fine sediments, or causing a visible turbidity increase in a ditch or on a road surface that drains into a Class I, II, or III watercourse. Access for road inspection and access to correct emergency situation shall be allowed at any time by a vehicles rated one ton or less." This restriction presents significant operational difficulties. Working with data from The Pacific Lumber Company (PALCO), it is estimated that the road restrictions alone could decrease the per-acre value of timberland by 5 to 10 percent.

Large per-acre impacts are also associated with the requirement in Alternative A that landowners retain the 10 largest trees along Class I watercourses. The requirement specifies that "recruitment of large woody debris to Class I watercourses shall be ensured by retaining the ten largest diameter confers (live or dead), on each side of the watercourse, per 330 feet of stream length, within 50 feet of the watercourse or lake transition line." This requirement will have minimal impact in some cases, but a major impact in others. PALCO data suggest that per-acre impacts range anywhere from 5 to 85 percent of value. Since Class I watercourses comprise only 3 percent of PALCO land, the diminished value across all ownership (a weighted value) is from 0.2 to 2.6 percent.

With regard to Class II watercourses, Alternative A provides that “at least 85 percent overstory canopy shall be retained within 50 feet of the watercourse or lake transition line. In an additional outer zone, overstory canopy closure shall be at least 65 percent. The overstory canopy in each zone shall be composed of at least 25 percent overstory conifer canopy post-harvest. The outer zone shall be 25 feet in width where side slope class is 30 to 50 percent. The outer zone shall be 75 feet in width where the slope class is greater than 50 percent. While attaining the canopy retention standards described in section 2.a.(5), recruitment of large woody debris to Class II watercourses shall be ensured by retain the five largest conifers (dead or alive) on each side of the watercourse per 330 feet of stream channel length, within 50 feet of the watercourse of lake transition line.”

These requirements are estimated to reduce timber harvest in affected areas by 35 percent, resulting in a similar loss in per-acre value. In the case of PALCO, 4 percent of total ownership is of this type, implying a weighted loss in value of between 1.0 and 1.4 percent.

“Inner gorge” requirements on Class I and II watercourses are also relatively expensive. Alternative A envisions that “where an inner gorge extends beyond a Class II WLPZ and slopes are greater than 55 percent, a special management zone shall be established beyond the WLPZ where the use of even aged regeneration methods is prohibited. This zone shall extend upslope to the first major break in slope (i.e., where the slope is less than 55 percent for a distance of 100 feet or more) or 200 feet as measured from the watercourse of lake transition line, whichever is less. Within this zone, methods and retention standards shall be as described in 14 CCR §§ 913.2, 933.2, and 953.2.”

The provision on even-age regeneration is forecasted to reduce harvest volumes by 50 percent in these areas, which account for 4 percent of PALCO lands. The implied diminution in value across all acres is between 1.6 and 2 percent.

Finally, Alternative A requires a 25-foot “protection zone” on each side of Class III watercourses for “slopes less than 30 percent and at least a 50-foot protection zone on each side of the watercourse for slopes greater than 30 percent. Retain all trees situated within the channel zone (i.e., bank-full channel) and trees that have boles that overlap the edge of the bank-full channel. Within the protection zones at least 50 percent of the understory vegetation shall be left post-harvest in an evenly distributed condition. All regeneration conifers, snags, large woody debris (LWD), and hardwoods shall be retained within the Class III protection zones except removal as necessary for yarding and crossings. Commercial timber operations will be allowed to “yard through” a Class III riparian management zone. Burning for purposes of site preparation shall not be initiated in the protection zones.”

This provision is anticipated to have a relatively minor impact on timberland values. PALCO estimates a loss in value of between 0 and 5 percent per acre. Affected lands comprise roughly 18 percent of their total ownership, with the result that the diminished value across all lands is between 0.0 and 0.9 percent.

Taking these five main components of Alternative A together, it is estimated that the total percentage reduction in timberland value is between 7.8 and 16.9 percent.

### F.13.1.2 ALTERNATIVE B

There are two ways in which certain sections of Alternative B could be implemented. The Commission could approve Section 17 and 18 for inclusion in the strategy as a recommendation to the California Department of Forestry and Fire Protection (CDF) and the Department to improve within existing law and authorities the implementation and enforcement of the Forest Practices Rules to ensure that timber operations are consistent with recovery of coho salmon. If existing law and authorities are found to be inadequate to provide for such improvements, then the Commission could alternately recommend that the Department and/or CDF seek legislation to provide such authority. This means that CDF would support the Department in the Timber Harvest Plan (THP) review process if the Department determined that any of these measures, as determined on a site-specific basis should be applied to protect coho salmon. Alternatively, the Commission could approve Sections 16, 17, and 18 together as guidelines (pursuant to FGC §2112) for issuance of Incidental Take Permits under FGC §2081(b) or consistency determinations under FGC §2080.1 where these recommended measures would fully mitigate take and at the same time contribute to the recovery of coho salmon. The effect of this would be to streamline the permitting process as an incentive for recovery. In accordance with FGC §2114, the guidelines would be part of the Commission's rulemaking for listing.

The main cost difference between Alternatives B and A is that the cost of the road restrictions is much lower in the former. Alternative B requires only that "for construction, reconstruction, upgrades, maintenance, and operation of roads within and appurtenant to THPs detailed site specific recommendations will be developed consistent with the *Handbook for Forest and Ranch Roads* (prepared by Pacific Watershed Associates, 1994c, for the Mendocino County Resource Conservation District in cooperation with CDF and the U.S. Soil Conservation Service. Mendocino Resource Conservation District, Ukiah, California. 163 pages.)" It is difficult to quantify the costs of this action item as it does not entail specific changes, and since many companies already follow these practices. Thus, while the road restrictions in Alternative B may well impose costs for some operations and at some locations, they are not quantified in this document.

Several aspects of Alternative B are identical to Alternative A. These include the requirement for Class I, II and III watercourses described above. One difference is for watercourses where an inner gorge is present. For Class II only, Alternative B requires that the landowner (1) provide 200' Watercourse and Lake Protection Zones (WLPZ); (2) require uneven-aged management; (3) prohibit tractor operations; and (4) require review of timber operations by a registered geologist. The cost of the “inner gorge” requirements is a loss in per-acre value of between 40 and 50 percent since even-age regeneration is still prohibited, but as opposed to Alternative A the loss applies only to Class II watercourses. The weighted average value of timberland is reduced between 1.2 and 1.5 percent.

One requirement that is contained in Alternative B and not Alternative A is that where a headwall swale is present, (1) utilize only single-tree selection prescriptions as per 14 CCR § 913.2(a)(2)(A) that retain the diameter distribution present before timber operations or a “thinning from below” prescription as per 14 CCR § 913.3(a) that retains dominant and codominant trees; and (2) require review of timber operations by a certified engineering geologist. This requirement will also prohibit even-age regeneration, resulting in a loss in land values of between 40 and 50 percent where it applies. PALCO estimates that 1 percent of its land would be affected by this provision, so that the weighted average loss in value from this provision is between 0.4 and 0.5 percent.

Taken together, Alternative B is estimated to reduce timberland values by 2.8 to 6.9 percent. The difference between the cost of this alternative and the cost of Alternative A is explained by the looser restrictions in road usage, construction and maintenance in the latter.

Using the calculated figures for percentage diminution in timberland value, it is possible to obtain a rough measure of the costs of the two alternatives. The percentage diminution in value should be applied to the value of timber harvesting rights per acre to obtain per-acre costs. Based on the advice of PALCO, we assume that the rights to harvest timber throughout the range of coho salmon habitat is valued at about $1,400 per acre on average. It follows that Alternative A amounts to a diminution in value of between $109 and $237 per acre. Alternative B will reduce values by between $39 and $97 per acre.

Since the publication of the November 2003 Public Review Draft of the recovery strategy new recommendations were added to Alternative B by the Department in response to public comments. Two of these recommendations require some discussion. The Department recommends in Section 19 that a “proof of concept” pilot program be developed and implemented to test a mathematical or scientific method of cumulative effects analysis as was suggested in the 2001 report, “A Scientific Basis for the Prediction of Cumulative Watershed Effects” (otherwise known as the “Dunne Report”, by the U.C. Committee on Cumulative Watershed Effects. The pilot program would be developed and implemented by a panel of experts such as those at the University of California in cooperation with the Department, CDF, and the State Water Resources Control Board. The cost of this recommendation is approximately $900,000. In addition, the Department recommends in Section 17.b that “For Class I watercourses, within the watercourse and lake protection zone retain trees that provide direct shading to pools, consistent with the conifer retention standards in the Threatened and Impaired Watershed Rules;” In discussions with PALCO and experts at the Department, it has been estimated that the impact of this additional recommendation will be negligible. In light of this minimal cost increase, the estimated total cost of implementing Alternative B has not been changed as a result of this additional recommendation. The limited impact of this additional recommendation is largely a result of the limited range of its impact; few THPs are impacted and when they are impacted the measure would affect the harvest of at most ten trees per THP. In addition, the measure generally will not result in a diminution of board feet harvested; landowners and/or companies would be allowed to substitute harvest elsewhere for the affected trees. This may increase the total costs of harvest, but not by a significant amount.

Data from CDF indicate that there are 3.84 million acres of privately owned timberland throughout the range of coho salmon habitat. Taking this acreage of Timberland Production Zones and multiplying by the weighted average per acre diminution in value, it follows that the cost of Alternative A is between $419 and $910 million. The cost of Alternative B is lower, and is estimated to fall between $151 and $373 million. These are present value calculations consistent with other fiscal cost estimates detailed in this report.

#### F.13.1.3. ALTERNATIVE C

Alternative C does not involve incremental costs above those estimated in other sections of this report. This alternative calls for implementation of road management plans, which may imply that costs will be incurred for decommissioning or treatment of roads, treatment of watercourse crossings, riparian revegetation, watershed planning, education, and monitoring of recovery measures. We have estimated the costs of these actions in other sections of the economic report.

To illustrate which previously estimated costs include those associated with Alternative C, we took the following steps: First, HSAs with at least 75 percent of land cover in forest were identified. Second, HUs containing these HSAs were identified. Third, the estimated costs of road treatment, road decommissioning, riparian revegetation, and treatment of stream crossings in those HUs were identified. These estimated costs are summarized in Table 1. Again, these are not new costs, but elements of previously estimated costs that include those associated with Alternative C. The total amount of these costs, excluding planning, education, and monitoring, is about $1.7 billion.

This report discusses previously that that total cost of watershed planning recommendations in the Recovery Strategy is estimated to be about $13 million.

Assuming that an equal amount will be spent each year on education and outreach, when these cost estimates are expressed in present value, assuming recovery over 25 years and a discount rate of three percent the estimated total cost of this class of recovery action is about $31 million.

There are about 30 recovery recommendations concerning biological or technical scientific studies. We estimate that the cost of recovery recommendations that are biological studies will be about $7 million. These costs are not discounted because this class of recovery action is generally assumed to be an interim action, occurring in the near future.

There are about 10 recovery recommendations that are clearly identifiable as monitoring efforts. The annual cost of the monitoring efforts is estimated to be about $1.4 million on the basis of the historical project costs described above. Assuming that the same amount will be spent each year on each monitoring effort, when these cost estimates are expressed in present value, assuming recovery over 25 years and a discount rate of three percent the estimated total cost of this class of recovery action is about $24 million.

Table F-21: Previously Estimated Costs of Elements of Recovery Strategy which Include Those Associated with Alternative C

| HU | Road decommissioning ($) | Road treatment ($) | Riparian revegetation ($) | Stream crossings treatment ($) | Total cost of Alternative C by HU |
|---|---|---|---|---|---|
| EEL RIVER | 126,822,230 | 190,777,692 | 29,858,170 | 11,293,206 | 358,751,299 |
| KLAMATH RIVER | 93,259,127 | 140,391,013 | 18,721,487 | 18,220,276 | 270,591,903 |
| MAD RIVER | 2,943,269 | 2,866,960 | 2,145,205 | 1,604,953 | 9,560,386 |
| MENDOCINO COAST | 13,291,428 | 133,158,247 | 743,507 | 284,571,592 | 431,764,775 |
| REDWOOD CREEK | 4,002,911 | 3,082,316 | 3,411,259 | 277,914 | 10,774,400 |
| ROGUE RIVER | 2,700,007 | 4,064,554 | - | 41,687 | 6,806,248 |
| RUSSIAN RIVER | 10,540,518 | 105,465,802 | 528,450 | 27,589,621 | 144,124,391 |
| SAN MATEO | 1,593,896 | 15,858,272 | 123,562 | 995,513 | 18,571,243 |
| SMITH RIVER | 31,529,016 | 47,463,350 | 2,468,586 | 3,831,737 | 85,292,690 |
| TRINIDAD | 8,089,361 | 12,177,614 | 103,304 | 548,880 | 20,919,159 |
| TRINITY RIVER | 124,142,457 | 186,882,354 | 3,241,052 | 13,791,476 | 328,057,338 |
| WINCHUCK RIVER | 935,637 | 1,408,495 | 35,989 | 138,957 | 2,519,078 |
| Total cost | 419,849,858 | 843,596,668 | 61,380,573 | 362,905,812 | 1,687,732,911 |

## F.13.2 SOCIOECONOMIC IMPACTS

Socioeconomic impacts associated with this class of recovery recommendations can be partially quantified at this time on the following basis. First, lost profit to the landowner is a negative socioeconomic impact. Second, there will be lost jobs as a result of implementing either Alternative A or Alternative B. There are few incremental impacts associated with Alternative C. If either Alternative A or Alternative B is implemented as incidental take permitting guidelines then some or all of the socioeconomic impacts calculated here would be attributable to listing.

To estimate employment and payroll effects, we assume that there are 6.4 jobs in logging and sawmilling per million board feet of timber harvest and an annual payroll of $30,000 per employee. These figures are based on an economic analysis of the proposed watershed rules announced by BOF on July 23, 1999 performed by Professor William McKillop of U.C. Berkeley.

These figures suggest that lost payroll per million board feet of timber lost is equal to $192,000 annually.

It is estimated that the total percentage reduction in timberland value is between 7.8 and 16.9 percent for Alternative A. Assuming that lost board feet of timber harvest is proportional to lost land value, annual payroll losses associated with this alternative range from $15 million to $32 million. Assuming recovery over 25 years and a discount rate of three percent the estimated total payroll impacts of this class of recovery action is about $261-$557 million. Total measured socioeconomic impacts equal these payroll impacts plus lost profits and so range from $680 million to $1.46 billion.

It is estimated that the total percentage reduction in timberland value is between 2.8 and 6.9 percent for Alternative B. Assuming that lost board feet of timber harvest is proportional to lost land value, annual payroll losses associated with this alternative range from $5 million to $13 million. Assuming recovery over 25 years and a discount rate of three percent the estimated total payroll impacts of this class of recovery action is about $94 million to $226 million. Total measured socioeconomic impacts equal these payroll impacts plus lost profits and so range from $244 million to $598 million.



## F.14 SHASTA-SCOTT PILOT PROGRAM

The methodology used to estimate the cost of implementing the Shasta-Scott Pilot Program (SSPP) is similar to the methodology used to estimate the cost of the general Recovery Strategy. However, using detailed information from the SSRT, cost estimates were developed for nearly every recovery recommendation.[44] These cost estimates are included in the SSPP document. This approach reflects the fact that the SSPP contains many recovery recommendations related to water management and acquisition that are not found in recommendations that apply throughout the range of the coho salmon in California. Table F-21 lists the categories of recovery recommendations identified in the SSPP and their fiscal cost and socioeconomic impacts. This subsection includes a discussion about how these cost estimates were developed.

Table F-22: Economic cost and impact of implementation of Shasta-Scott Pilot Program

| Recovery action | Fiscal costs ($) | Socioeconomic impacts ($) |
|---|---|---|
| 1 Water management | 10,334,024 | |
| 2 Water augmentation | 60,217,676 | (6,143,359) |
| 3 Habitat management and restoration | | |
| • Barriers to passage | 7,059,636 | 4,211,782 |
| • Instream restoration | 3,797,400 | 2,453,750 |
| • Streamside restoration | 324,610,877 | 152,567,375 |

[44] No cost estimates have been developed for P-6, P-7, WUE-6a, WUE-6b, and WUE-6c. These recommendations are too speculative or vague at this time to cost.

| | | |
|---|---|---|
| • Road treatment | 84,764 | 63,439 |
| • Other habitat restoration | 36,030,892 | |
| 4 Protection | 1,244,789 | |
| 5 Water use efficiency | 3,200,000 | 2,020,000 |
| 6 Monitoring and assessment | 10,604,000 | |
| 7 Education and outreach | 8,832,520 | |
| Total | **466,016,578** | **155,172,987** |

Source: Authors' calculations.

### F.14.1 WATER MANAGEMENT

In close consultation with the SSRT, the economists estimated the cost of each individual recovery action related to water management. The total cost of this class of recovery action in the SSPP is estimated to be about $10 million. There are no significant socioeconomic impacts associated with this class of recovery recommendations.

### F.14.2 WATER AUGMENTATION

An important category of recovery recommendation in the SSPP is water augmentation. To estimate the cost of this class of recovery recommendations, it has been necessary to make strong assumptions about (1) the extent to which instream flows will need to be augmented in the SSPP region for coho salmon recovery, and (2) the means by which this goal will be accomplished.

The Department and the SSRT have stated that, at this time, it is not possible to determine with certainty the amount of water that will be left in streams in the SSPP region for coho salmon recovery purposes. An estimate of the amount that will be needed has been made for the purposes of calculating the cost of implementing the Recovery Strategy, but neither the SSRT nor the Department endorses this number as a basis for policy action. Solely for the purposes of this illustrative calculation, it was assumed that instream flows in the SSPP region will be increased by 8,400 acre-feet per year.

The SSPP contains several recovery recommendations intended to result in increased instream flows for coho salmon. They include, but are not limited to, verifying compliance by water rights users, donation of unused water rights, substitution of groundwater for surface water for irrigation, and water acquisition. It cannot be known ex ante how much water will be procured for coho salmon through each of these strategies. To estimate the cost of securing instream flows for coho salmon, the SSRT has suggested that it is appropriate to assume that increased instream flows will be generated solely through the acquisition of water rights from willing sellers. This assumption is made only for the purposes of an illustrative calculation of the cost of coho salmon recovery and should not be taken as an endorsement of this approach to increasing instream flows in the SSPP region.

Using the assumptions about the amount of water to be acquired and the methods by which these flows are to assured, the cost of instream flows augmentation in the SSPP region was estimated using the methodology described in section F.8.1. The assumption was made that the price of an acre-foot of water will be about $100 per year. Since the SSPP specifies that a trust will be created with an endowment to be used for securing water rights, it is possible to estimate that, in present value, the cost of water augmentation in the SSPP region will be on the order of $60 million (assuming a 25-year recovery period and a 3 percent discount rate). The socioeconomic impacts associated with this acquisition of water for fish, in the form of lost jobs and other economic activity will be about $6 million in present value.

### F.14.3 HABITAT MANAGEMENT AND RESTORATION

The cost of habitat management and restoration in the SSPP region was estimated using the methodology described in section F.2.1. The SSRT provided estimates of the amount of each habitat restoration activity that would be undertaken in the region for the purposes of coho salmon recovery. For other habitat management and restoration activities that do not fall into the categories listed in section F.11.1 (e.g., Scott HM-1-2c, Scott HM-2c, Scott HM-3c) specific cost estimates were developed in consultation with the SSRT. Every attempt has been made to ensure that the cost of monitoring and assessment and education and outreach activities identified as costs associated with habitat management and restoration are not double-counted in this accounting exercise. These costs are included as part of the monitoring and assessment and education and outreach activities for the purpose of developing the cost and impact estimates summarized in Table F-21.

### F.14.4 PROTECTION

This class of recovery recommendations includes the development of best management practices. The assumption was made that it will cost about $60,000 to develop and disseminate (see section F.11.1 for a discussion of the development of this figure) and several recommendations for which costs cannot be estimated at this time.

### F.14.5 WATER USE EFFICIENCY

The most important water use efficiency recommendation that is not a study or education effort is the proposal that ditch-lining be implemented to reduce water loss. The SSRT has stated that approximately 20 miles of ditches could be eligible for lining. Based on a review of a similar project implemented in the Oroville Wyandotte Irrigation district in 2003 (and proposed in 2001), the economists estimated that this action should cost about $161,000 per mile of ditch, or around $3.2 million for all 20 miles of ditches. Associated positive socio-economic impacts would be on the order of $2 million.

If the water savings estimates in the Oroville Wyandotte Irrigation district are indicative of the cost-effectiveness of ditch-lining in the SSPP region, then it is possible to estimate that this recovery action would cost about $600 per acre-foot of water. This is about six times the estimated cost of water acquisitions achieved through fallowing in this region.

### F.14.6 MONITORING AND ASSESSMENT

The cost of monitoring and assessment actions identified in the SSPP were estimated by (1) relying on specific cost estimates provided by the SSRT where possible, and (2) by relying on historical average costs of monitoring and assessment activities where these estimates are not available. The estimated cost of this class of recovery action in the SSPP region is about $7 million, with no significant socio-economic impacts.

### F.14.7 EDUCATION AND OUTREACH

The cost of education and outreach actions identified in the SSPP were estimated by (1) relying on specific cost estimates provided by the SSRT where possible, and (2) by relying on historical average costs of education and outreach activities where these estimates are not available. The estimated cost of this class of recovery action in the SSPP region is about $9 million, with no significant socio-economic impacts.

## F.15 AGGREGATE COSTS AND ECONOMIC IMPACTS

Table F-22 summarizes estimates of the aggregate costs and socioeconomic impact of coho salmon recovery under the strategy. These estimates include the cost of implementing the SSPP (shown on a disaggregated basis) and the mid-point estimate of the cost of implementing the timber management alternatives, but exclude the cost of water acquisition in all regions outside of the SSPP area. These figures also exclude the costs and impacts of actions that cannot be quantified at this time. Thus, these costs and impacts may only partially reflect the cost of coho salmon recovery under the strategy. On the other hand, as stated before, these aggregate cost estimates may overestimate the cost of Recovery Strategy implementation because some of the costs may be incurred even if the Recovery Strategy were not implemented. In addition, these aggregate cost estimates may overestimate the cost of Recovery Strategy implementation to the extent that some of the costs may be incurred as a result of actions taken to avoid take of coho salmon or to fully mitigate impacts of the authorized take of coho salmon once the species is listed.

The total measured fiscal costs of implementing the Recovery Strategy are about $5 billion dollars. Of these measured costs, about $466 million, or 9 percent of total measured costs, will be incurred in the SSPP region. The actual fraction of costs incurred in the SSPP region will be less than this because the cost of water acquisition has been explicitly measured for the SSPP, but has not been measured for the rest of the range. Nonetheless, a notably large portion of costs will be incurred in these HSAs.

Restoration costs are higher in the SONCC Coho ESU than the CCC Coho ESU, likely because coho salmon are more widely distributed within the SONCC Coho ESU. Costs are especially high in the Klamath River HU, where Iron Gate Dam is located. High costs were also noted in the Mendocino Coast and Trinity River HUs. These three HUs, combined, account for over 85 percent of measured restoration costs.

Monitoring, evaluation, planning, education, and outreach costs are about $90 million dollars. This is about 2 percent of total estimated fiscal costs. There are no significant socioeconomic impacts associated with these actions.

Implementing the recommendations for timberland management could result in costs ranging from $150 million to $910 million, depending on which alternative, or combination of elements from those alternatives, is adopted. If Alternative A were adopted, costs would be in the range of $419 million to $910 million. Costs would be lower if Alternative B were adopted, in the range of $151 million to $373 million. There are few incremental costs associated with Alternative C. This report presents a total cost estimate that includes the average of timberland management Alternatives A and B, which is $463 million.

Restoration activities will generate positive socioeconomic impacts. Socioeconomic impacts generated from restoration equal about one-half of the fiscal costs of restoration or $2.1 billion. The socioeconomic impacts of water acquisition in the SONCC Coho ESU will be negative (for the SSPP these negative impacts equal about $6 million), as will the socioeconomic impacts of timberland management changes. Negative socioeconomic impacts of the timberland management changes are estimate to range from about $225 million to about $1.46 billion.



Table F-23: Summary of cost and impacts of coho salmon recovery

| Class of recovery action | Fiscal Costs ($) | Socioecon. Impacts ($) |
|---|---|---|
| Habitat Restoration | | |
| SONCC Coho ESU | 1,680,502,407 | 1,082,338,237 |
| CCC Coho ESU | 1,465,138,565 | 902,965,885 |
| Total excl. SSPP | 3,145,640,972 | 1,985,304,122 |
| Scott | 117,826,696 | 56,002,243 |
| Shasta | 217,725,981 | 103,294,103 |
| Other SSPP restoration | 36,030,892 | |
| Total SSPP | 371,583,569 | 159,296,346 |
| Total incl. SSPP | 3,517,224,542 | 2,144,600,468 |
| Monitoring, evaluation and planning | | |
| Total excl. SSPP | 44,000,000 | 0 |
| Total SSPP | 10,604,000 | 0 |
| Total incl. SSPP | 54,604,000 | 0 |
| Education and outreach | | |
| Total excl. SSPP | 31,000,000 | 0 |
| Total SSPP | 8,832,520 | 0 |
| Total incl. SSPP | 39,832,520 | 0 |
| Water management | | |
| Total excl. SSPP | | |
| Total SSPP | 10,334,024 | 0 |
| Water use efficiency | | |

| | | |
|---|---|---|
| Total excl. SSPP | | |
| Total SSPP | 3,200,000 | 2,020,000 |
| Water acquisition | | |
| Total excl. SSPP | | UNKNOWN |
| Total SSPP | 60,217,676 | (6,143,359) |
| Other (includes SSPP Protection and easements) | | |
| Total excl. SSPP | 808,553,878 | |
| Total SSPP | 1,244,789 | |
| Timberland management | | |
| Alternative A | 419,000,000-910,000,000 | (1,460,000,000)-(680,000,000) |
| Alternative B | 151,000,000-373,000,000 | (598,000,000)-(224,000,000) |
| Alternative C | FEW INCREMENTAL COSTS | FEW INCREMENTAL COSTS |

Source: Authors' calculation. Habitat restoration includes removal of barriers to fish passage, riparian revegetation and streambank improvements, placement of LWD and improvements in instream complexity, and road treatment and decommissioning. SSPP is the Shasta and Scott River Pilot Program No cost estimates are available for water acquisition in the CCC or SONCC excluding the SSPP. Excludes impacts identified but not quantified.

## F.16 Impacts identified but not quantified: Permitting and enforcement

An important unresolved issue with the cost of coho salmon recovery under the strategy is the role of enforcement of permits and take restrictions. There is some amount of unpermitted water diversion from streams containing coho salmon, for example, and some diverters use more than their allowable quantity. With regard to other issues like fencing, existing take restrictions may require that ranchers be fencing and constructing troughs more than is currently the case. This analysis has not attempted to parse out the total quantity of actions required for recovery as opposed to actions required by the listing of the coho salmon. Instead the costs of recovery have been calculated based on the increment of various actions relative to the status quo.

While a full treatment of enforcement is beyond the scope of this study, from an economic point of view it should be mentioned that the fiscal costs of coho salmon recovery under the strategy can be reduced, dramatically in some cases, from enforcement of existing law.

A related question arises in the area of water quality concerns. Several recommendations were directed at reducing pollutant loads (including sedimentation) that may adversely affect coho salmon recovery. The regional water quality control boards in California are formulating and implementing plans to reduce pesticide runoff. This observation raises the question about whether the costs of water quality improvement actions identified by the CRT should be all or partially attributable to coho salmon recovery, and which would be incurred as a result of the Clean Water Act or other statutes and regulations. TMDL regulations, for example, are quite relevant to coho salmon recovery. Costs attributable to this process should not be counted as a cost of coho salmon recovery if the regulations would have been enacted anyway.